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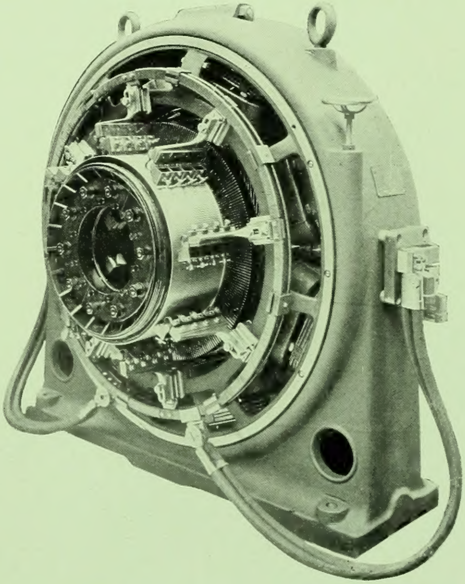

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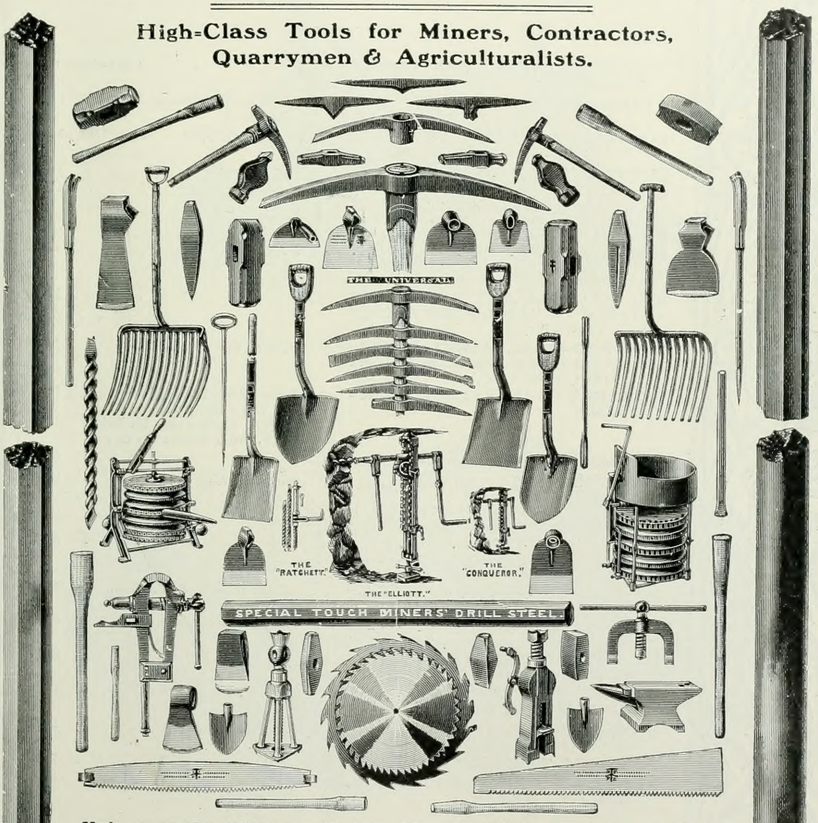
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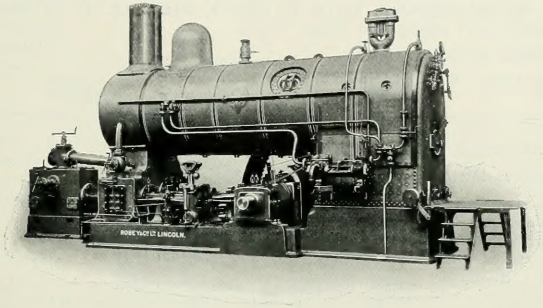

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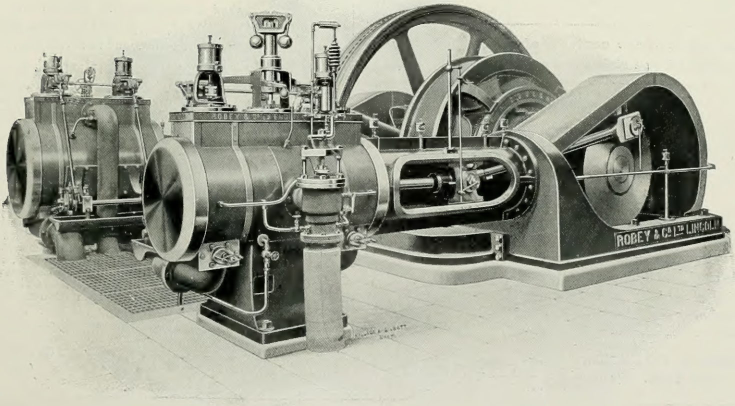

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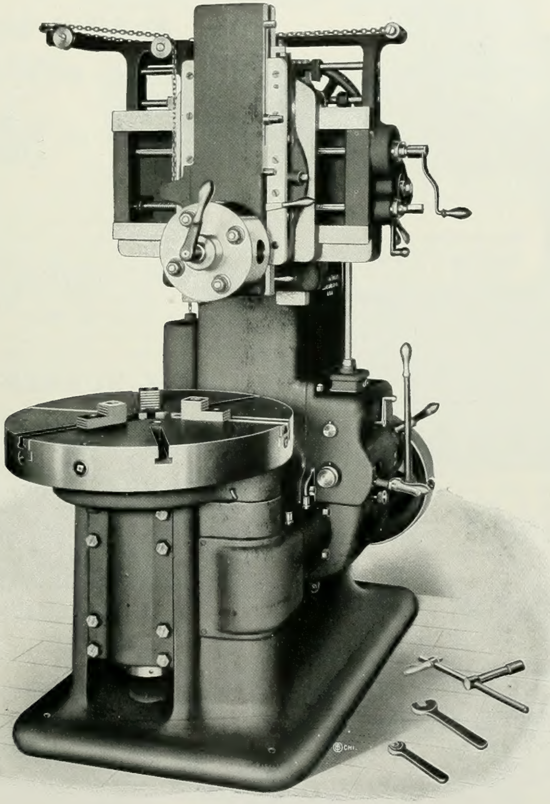

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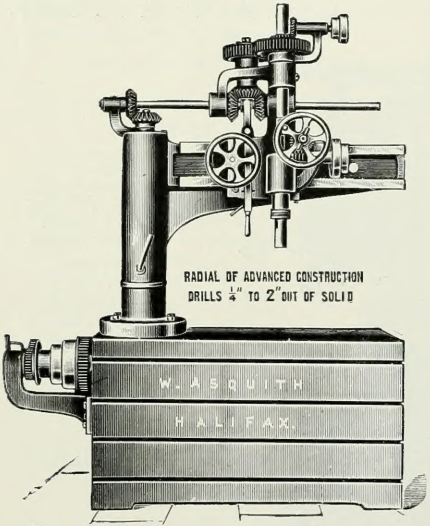

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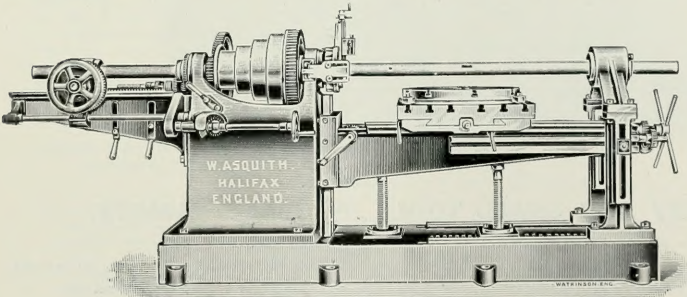

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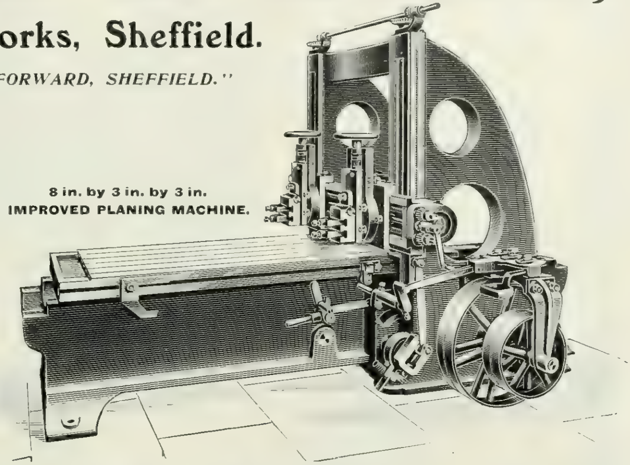

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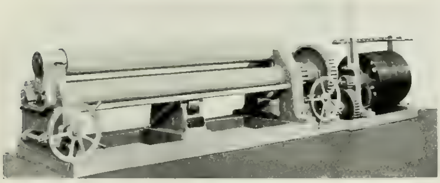

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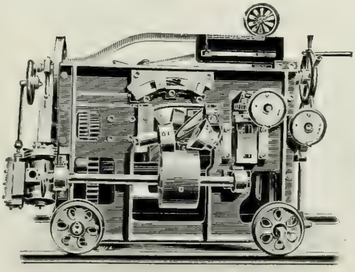

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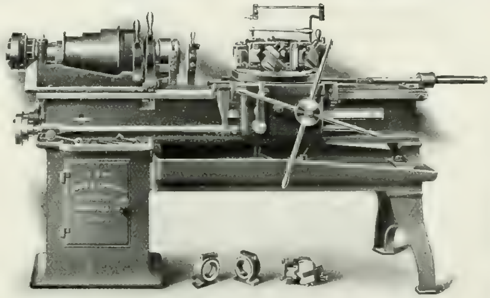

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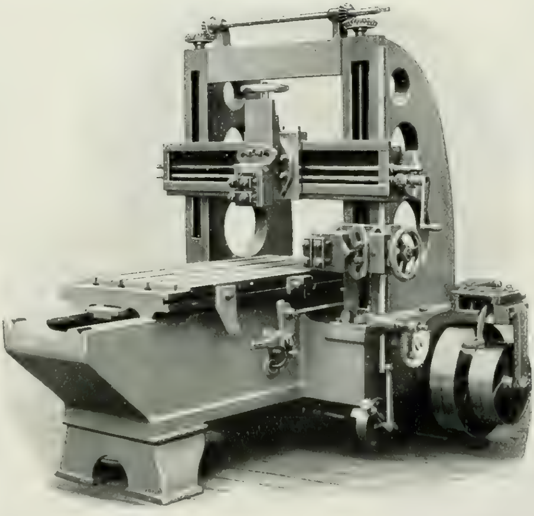

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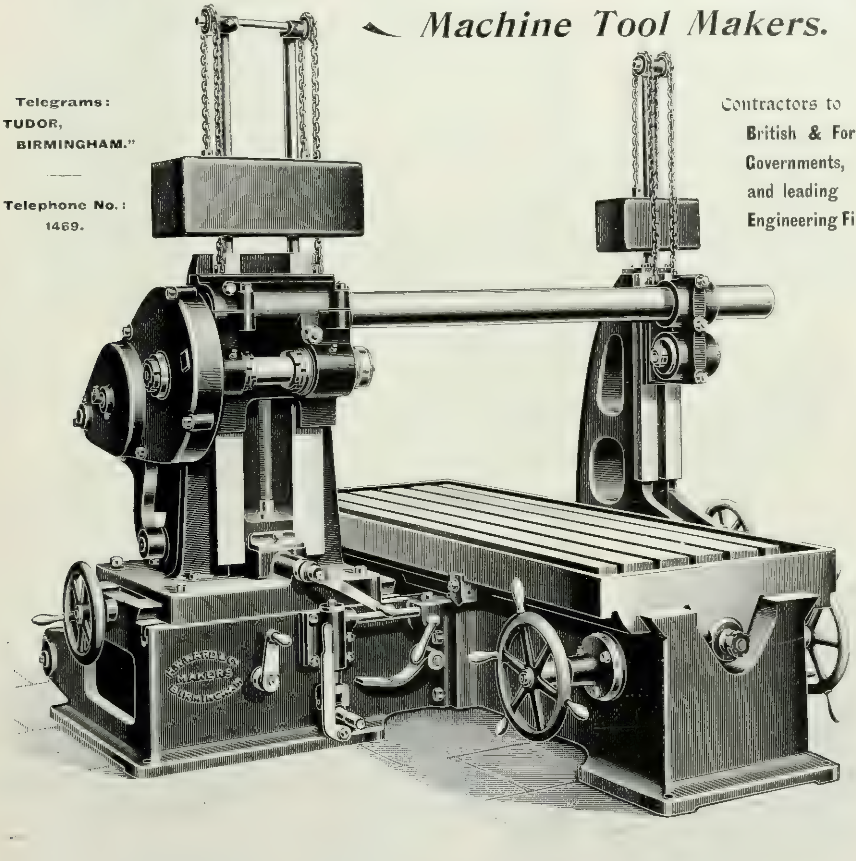

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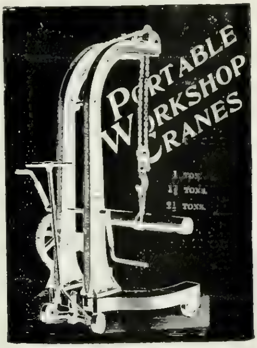

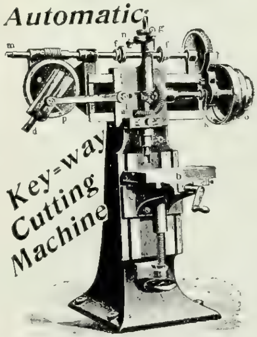

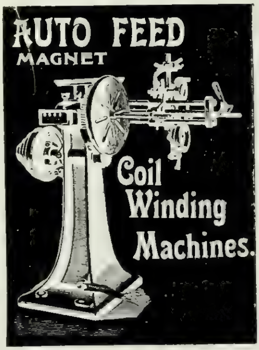

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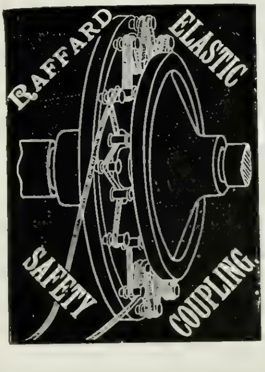
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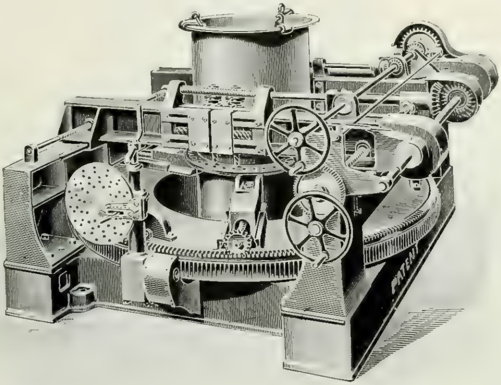

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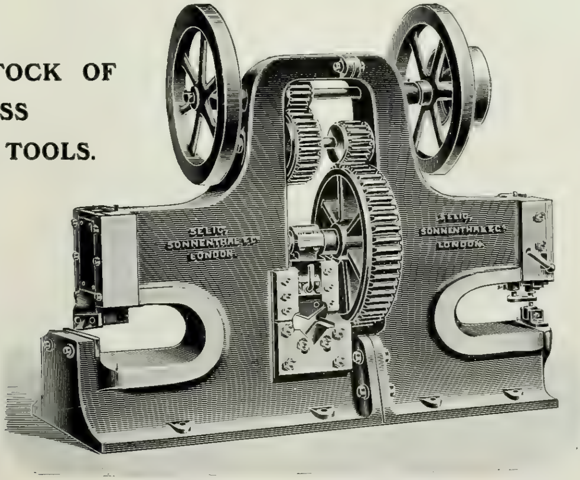
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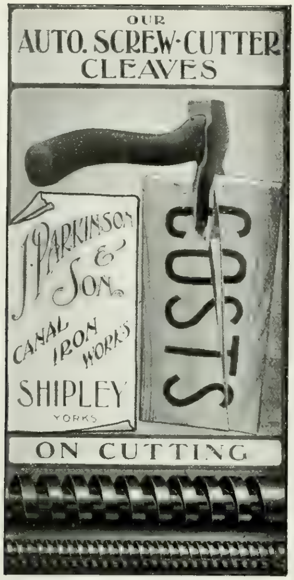

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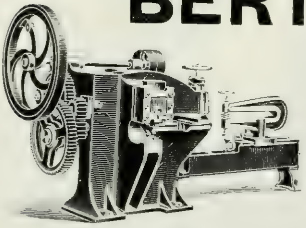

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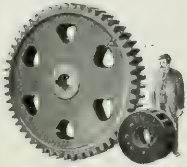

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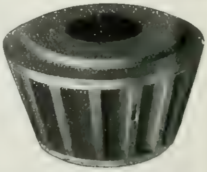

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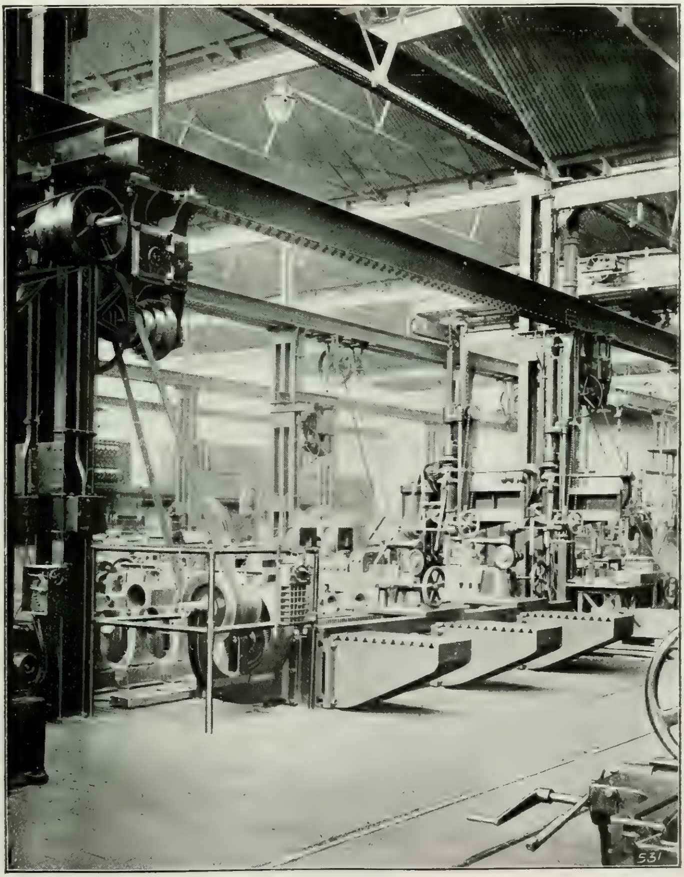

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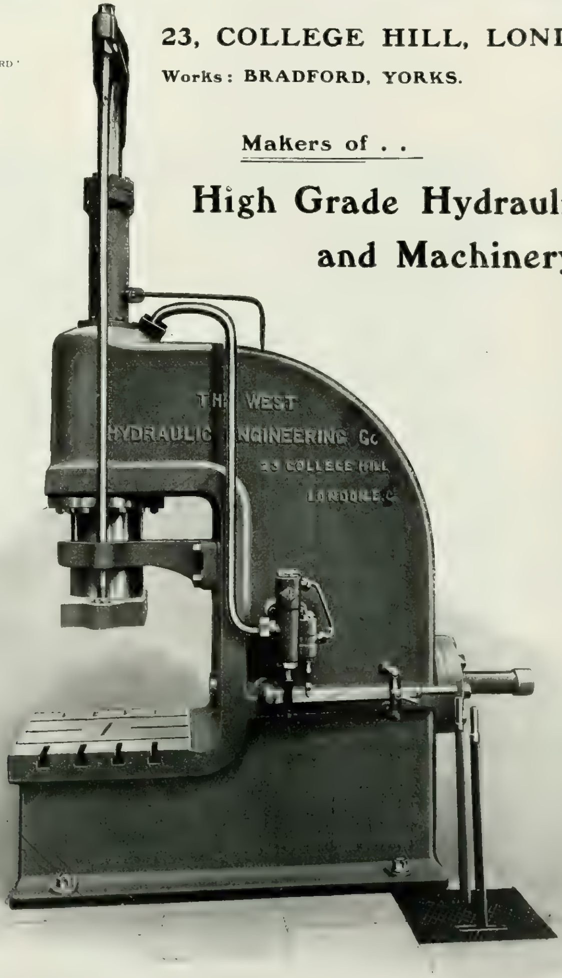

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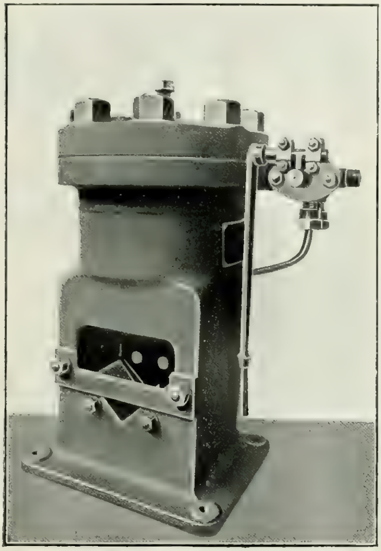

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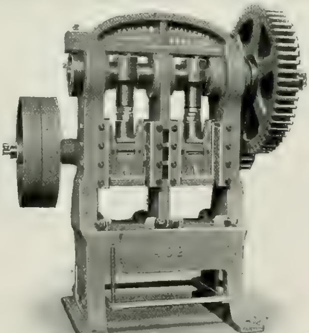

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THE

Jos. C. NICHOLSON TOOL Co.

Engineers and Machine Tool Makers,

Write for our
New Pocket
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Telegrams:
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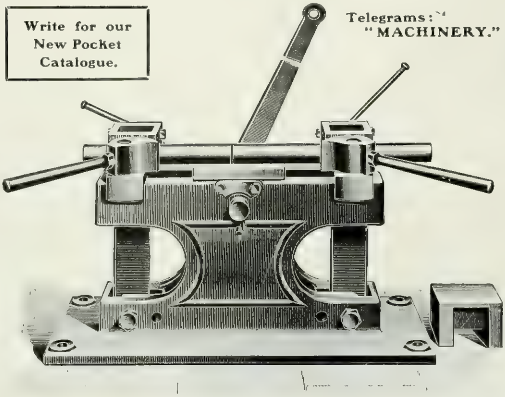
CITY ROAD TOOL WORKS,

NEWCASTLE-ON-TYNE.



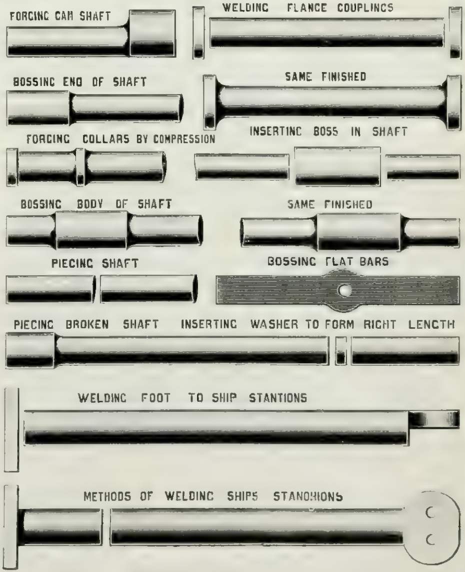
A LABOUR SAVER
for the
BLACKSMITH'S SHOP.

The "Standard" Hand Power

Welding & Forging Machine.

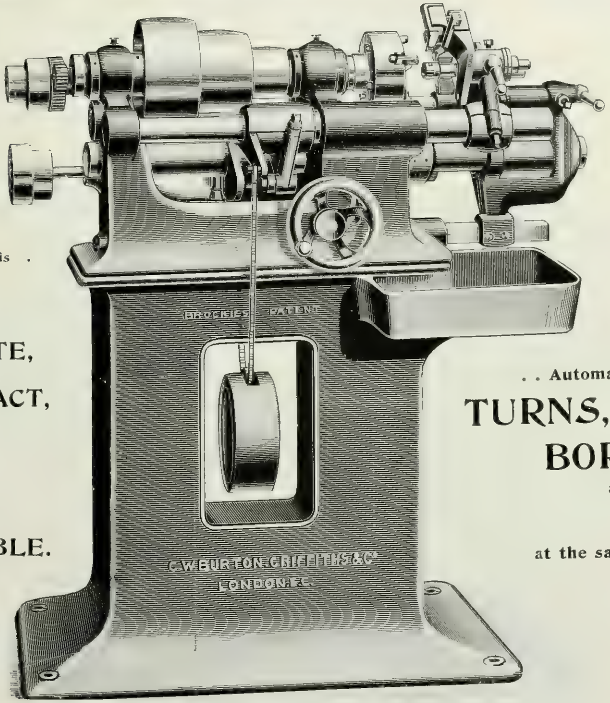
Two men can weld bars and shafts on this machine up to three inches diameter, and three men up to six inches diameter. One man on the lever gives a pressure on the bar of 20 tons, which can be utilised to compress collars and bosses in iron bars.

THE adjoining illustration shows samples of work which can be effectively and economically done on this machine, such as welding flange couplings on shafts, and the flats on to ships' stanchions. Bossing flat bars by compression, forming collars and bosses in round bars, inserting bosses of larger diameter, &c. No smith's shop is complete without this machine.



"TRIPLE ACTION"

CHUCKING MACHINE



. . This Machine is .

RAPID,
ACCURATE,
COMPACT,
CHEAP,
SIMPLE,
and
DURABLE.

. . Automatically . .

TURNS,
BORES,
and
FACES
at the same time.

Takes Castings (Iron or Brass) up to 6in. diameter.
No special tools required. Ordinary shop tools used.
One boy runs from 2 to 4 machines.

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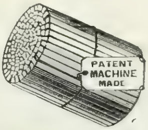

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M. GLOVER & Co.

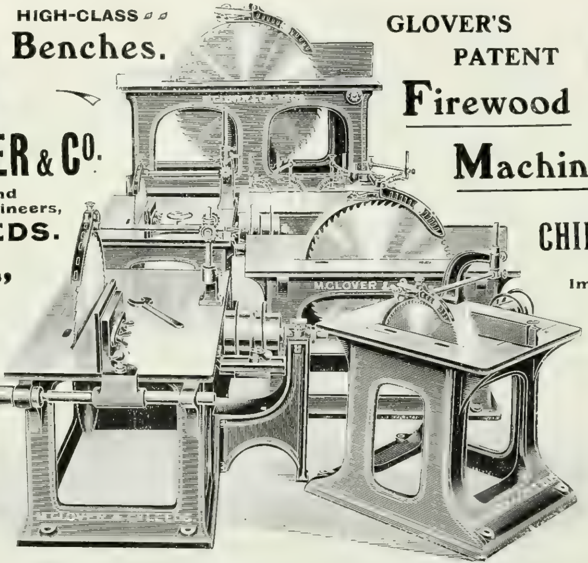
Patentees and
Saw Mill Engineers,
LEEDS.

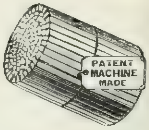
"Ideal"
SAW
GUARDS.

N.B.

"IDEAL" Saw Guards are giving the greatest satisfaction possible in many hundreds of leading works.

THEY FIT OTHERS CAN NOT.





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Improved Patent
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Special Machines designed for Special Purposes.

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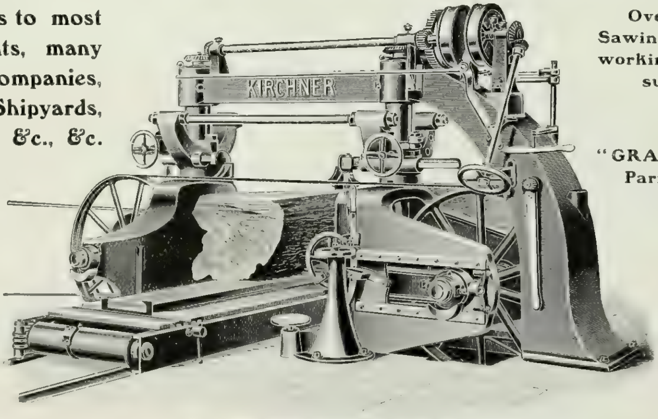

HFA Large Patent Horizontal Band Mill.

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"GRAND PRIX," Paris. 1900.

Over 70 Gold Medals and other Highest Distinctions.

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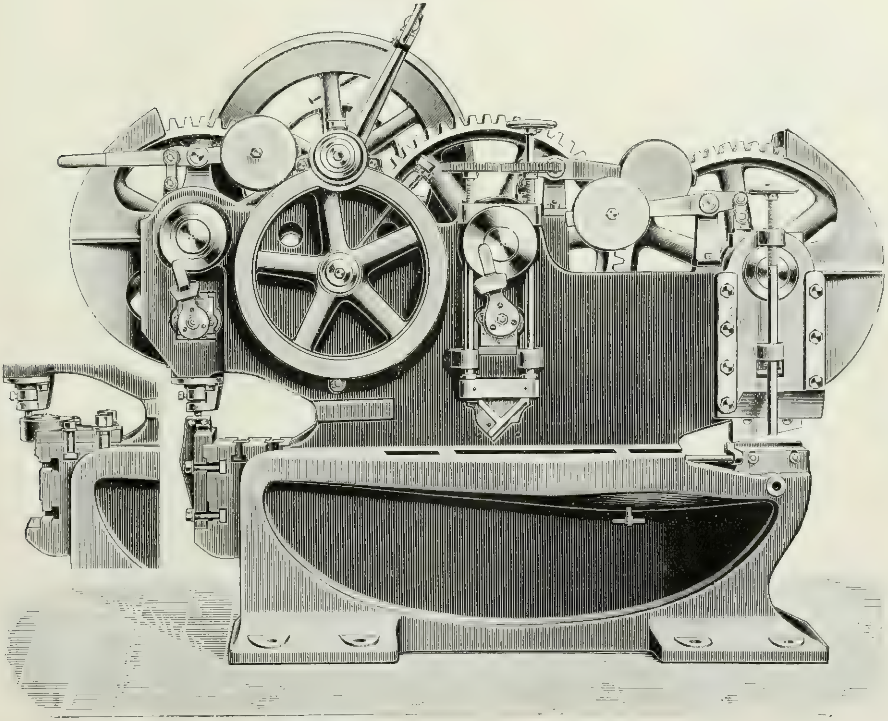

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National Telephone
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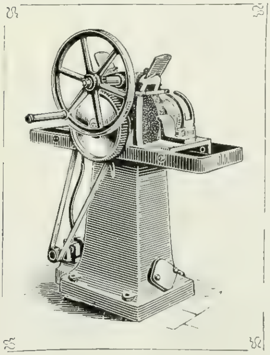

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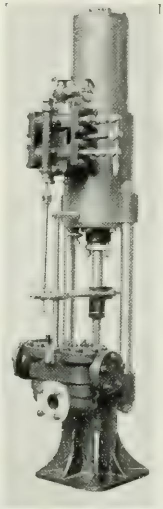

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ECONOMICAL AND EFFICIENT.

We deliver 100 lbs. of Water for the expenditure of 1 lb. of Steam. This with our 2,000 gallon Pump, and a much higher efficiency as the size of the Pump increases.

AN IDEAL PUMP FOR GENERAL BOILER FEEDING PURPOSES.

APPLY FOR PARTICULARS.

LOBNITZ' GOLD DREDGERS ARE AT WORK IN BRITISH NORTH AND SOUTH AMERICA, AFRICA, ASIA, &c.

LOBNITZ & CO., LIMITED,
Manufacture Dredge Plant. Most Improved Designs.

GOLD DREDGERS.

All parts made to gauge. Quick delivery of standard sizes.

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POWERFUL PORTABLE LIGHT FROM OIL
Up to 5,000 Candle Power.

For ENGINEERS, CONTRACTORS, SHIPYARDS, RAILWAYS, COLLIERIES, QUARRIES, MINES, HARBOURS, DOCKS, etc.

OVER 17,000 SOLD.

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Adopted by 26 Governments and all leading Firms
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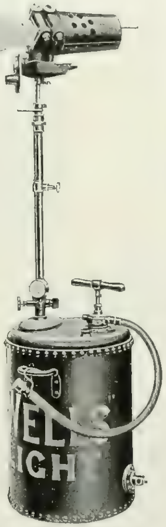

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Burns either heavy Wells' Oil or Petroleum, but the former is very cheap and gives about 30 per cent. more light than petroleum.

The Wells 'Lightning' Painter and Lime and Colour Washer

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Over 500 Plants supplied.

For Engineers, Contractors, Shipbuilders, Bridge & Girder Works, Boiler Shops, Wagon Works, Gas Works, etc., etc.

Adopted by **12** Governments and the Principal Railways and Gas Works in Great Britain

THE Lightning Painter is operated by Compressed Air. The paint or lime-wash is sprayed evenly and continuously through a flexible tube and nozzle supplied with compressed air, either from existing air main or from our special Compressors. Where compressed air is available, only a Reducing Valve is required, which we supply, **25s.** each, for use with the Painters.

No. 1 Painter	£25	0s.
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Single Air Compressor	£17	10s.
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Works: Cheetham, Manchester.

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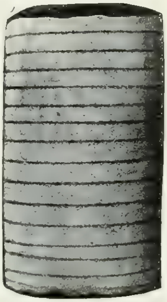
Calyx Patent **CORE** Drill.

CORES. 3 in. to 20 in. DIAMETER.

Petroleum and Artesian Wells.
True, Straight, and Permanent.
Applied successfully by



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COAL CORES A SPECIALITY.

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STEEL & MALLEABLE IRON CASTINGS FOR ENGINEERS & TOOL MAKERS
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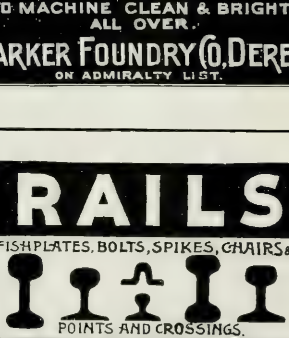

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WILLIAM FIRTH LTD
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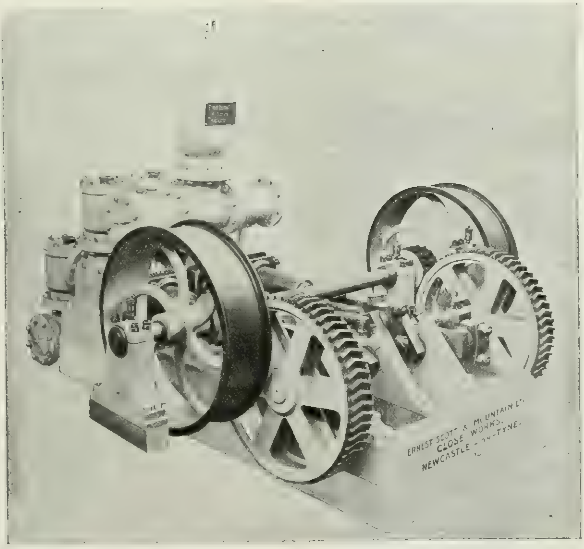
MINING MACHINERY

Pumps, Haulage Gears, Coal Cutters, Drills. Engines, Dynamos, Motors, Fans, Cranes, &c., &c.



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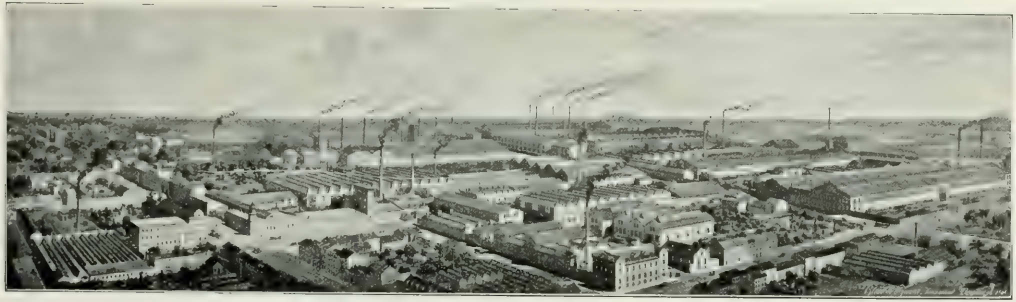

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LOCOMOTIVES, AND STATIONARY BOILERS,
Of Special Construction for burning Brown Coal.

Completely equipped Testing Works at Kalk, for testing bulk samples of Coal and Ore (3-10 tons) before tendering Plants.

Steam Engines, Pumps, & Fans of all kinds.
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WINDING ENGINES.

Riedler Pumps.
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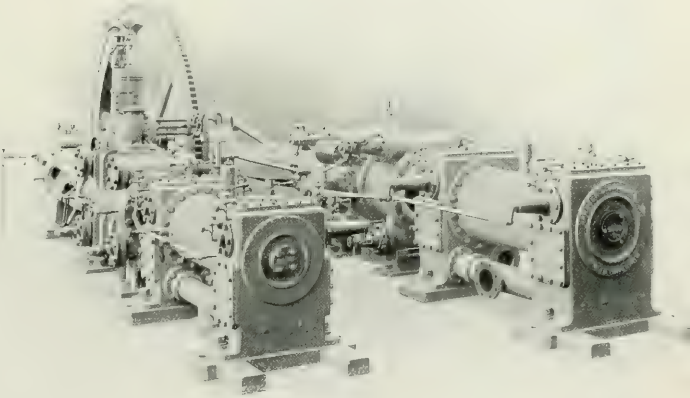

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Compound Air and Steam 4,230 cubic feet of air to 80 lbs. pressure.

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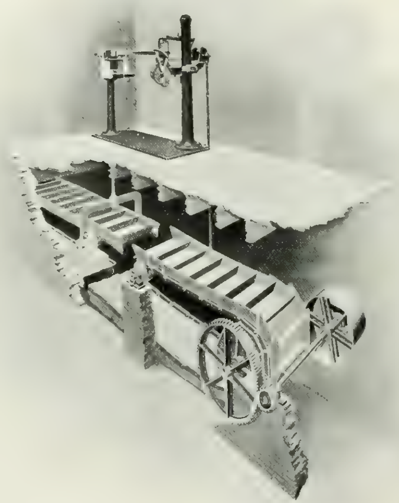

Advantages.

The coal is not broken.

It is weighed while travelling.

Machine requires no attention.

It shows the aggregate amount of material passed over the conveyor in any given time.

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COAL,
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Automatic Hoisting & Conveying Appliances

For the rapid and economic
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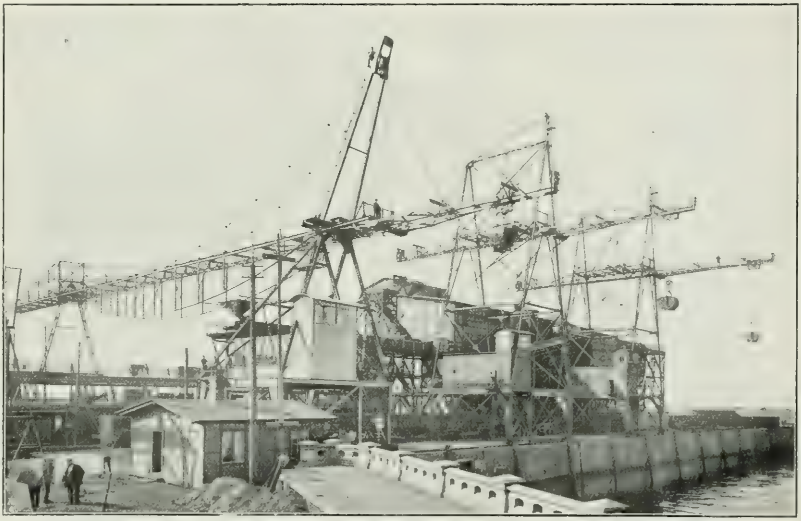
ELECTRIC OR STEAM DRIVEN.

Gold Medals. Highest Awards.



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These Three Cranes unload 1 500 Tons Cargoes in Ten Hours.

SHIPBUILDING and YARD CRANES.

Cable Hoist Conveyors. Blast Furnace Hoists.

THREE-MOTOR ELECTRIC TRAVELLING CRANES.

Improved Band Friction Hoisting Machinery.

Plants also designed in connection with BLEICHERT'S WIRE-ROPE TRAMWAYS,
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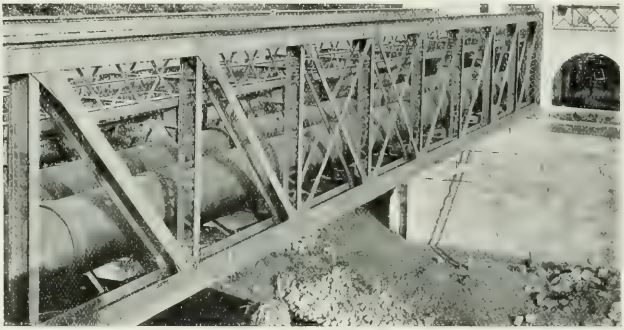

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For BOILERS
HYDRAULIC PRESSES
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SHAFTING
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GENERAL
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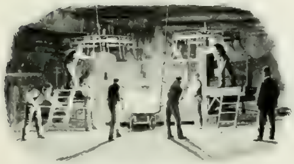
Farnley Iron.



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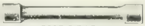
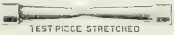


TEST PIECE



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OF EVERY
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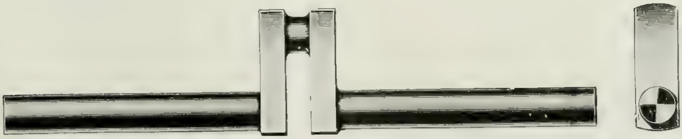

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We make the forgings.

Precision
at moderate cost.

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You do the finishing.

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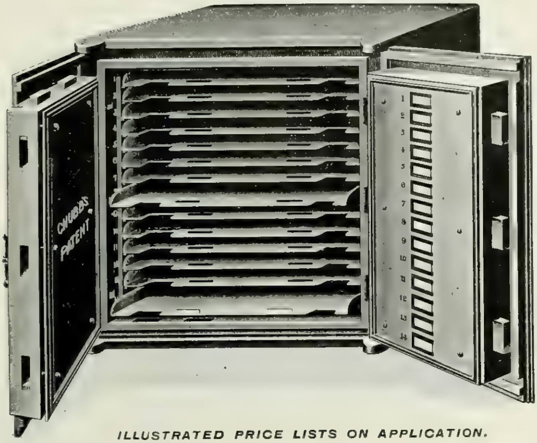

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To suit 3-16ths to 3-in. Nuts
ALL SIZES SUPPLIED FROM STOCK.
SOLID DROP FORCED.
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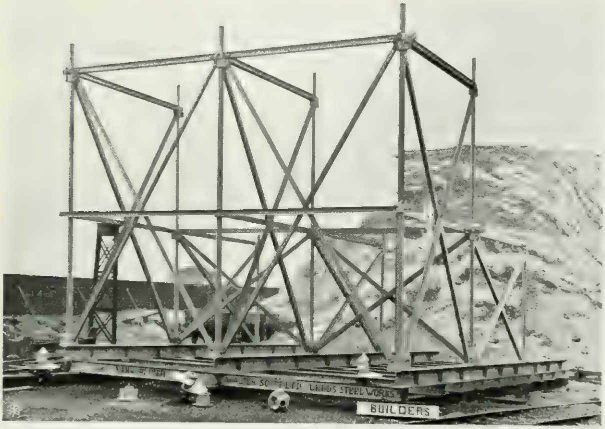

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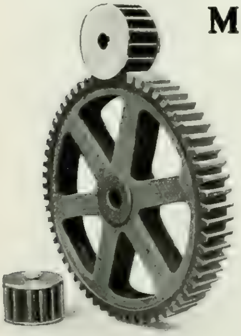

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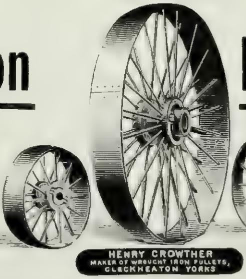

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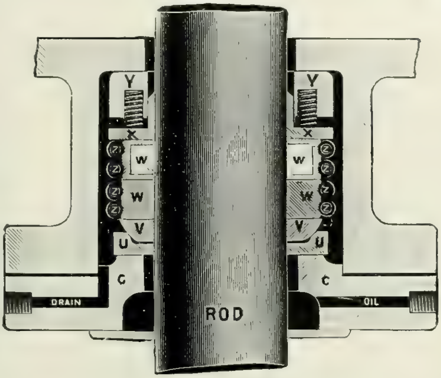

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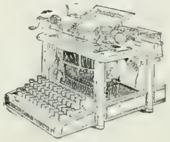

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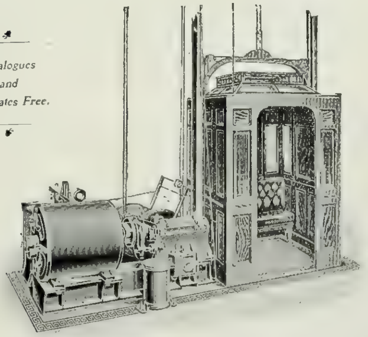

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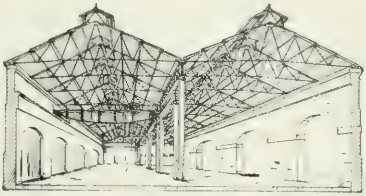

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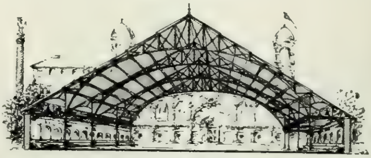

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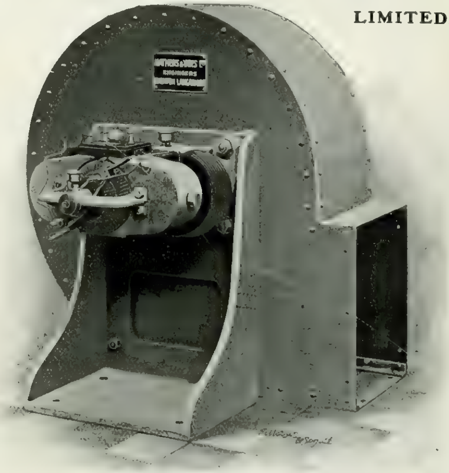

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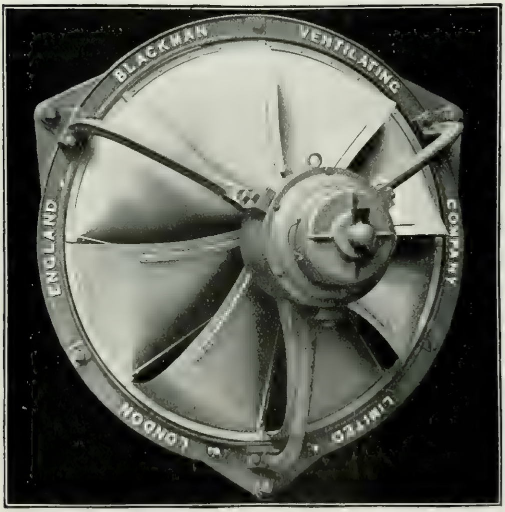

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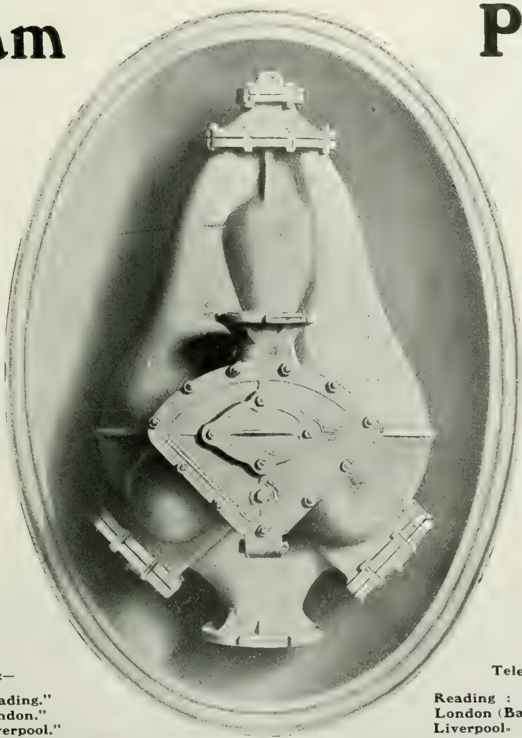

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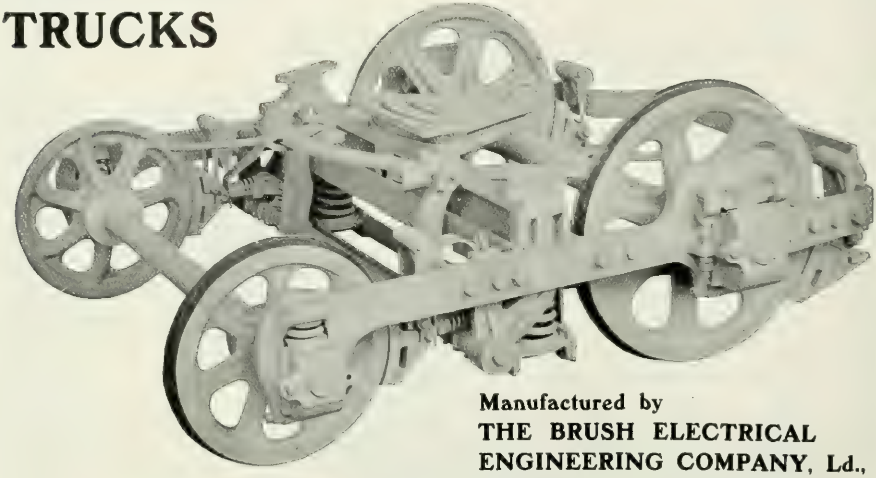

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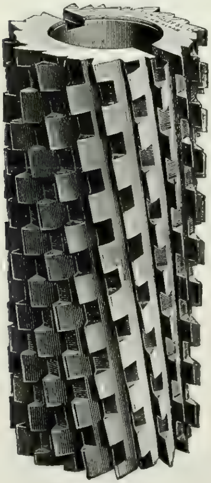

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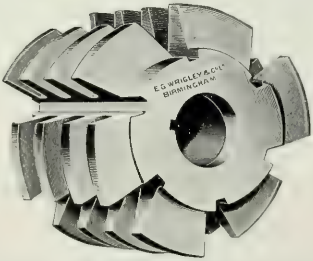
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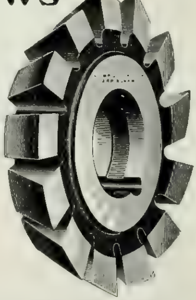

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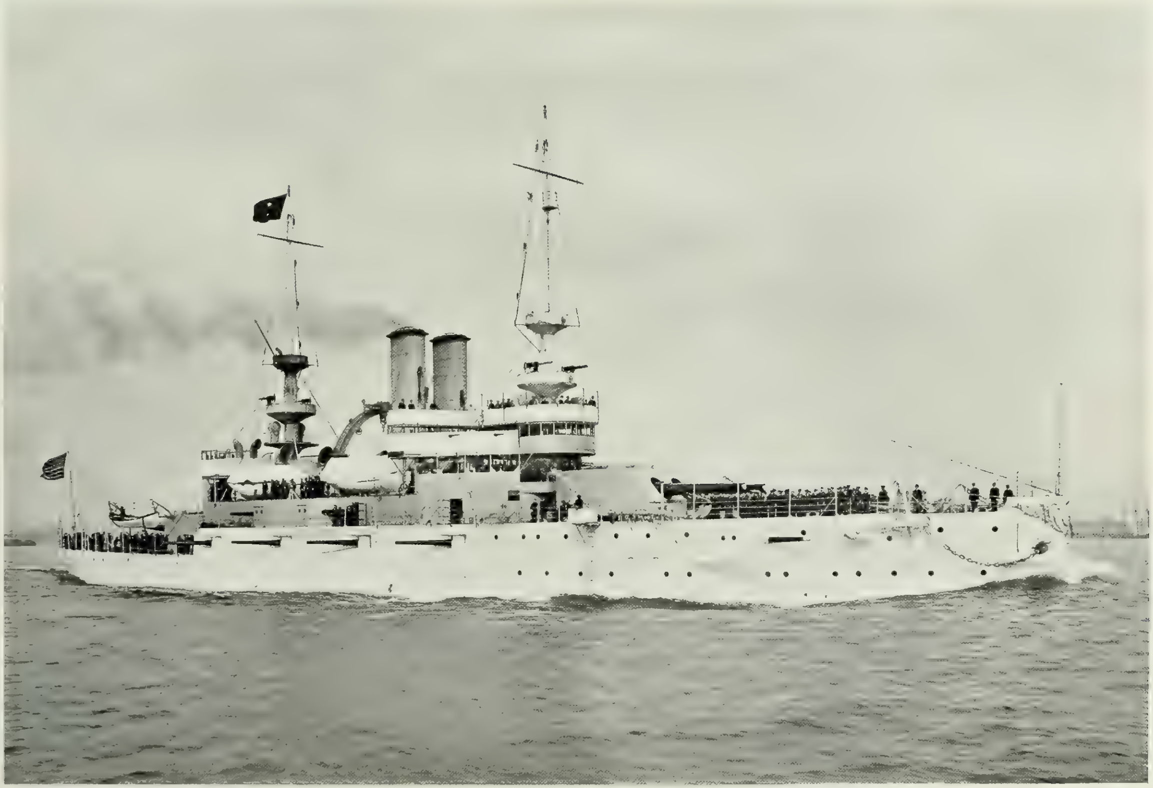

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THE UNITED STATES BATTLESHIP "ILLINOIS."

Laid down February 10th, 1897 Launched, October 4th, 1898. Displacement, 11,565. Heaviest Gun, 13in. Thickest Armour, 16·5 I.H.P., 10,000. Nominal Speed, 16 knots.
Vide "Naval Notes."

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

VOL. I. LONDON, AUGUST, 1902. NO. 2.

"WIRELESS" TELEGRAPHY.

BY

SIR W. H. PREECE, K.C.B., F.R.S., &c.

In this article the author gives a short account of his relations with Mr. Marconi, and indicates the progress which has been made in Ætheric Telegraphy. He points out the purposes for which it can best be applied, at the same time discussing its present value as a commercial system.—ED.

THE first preconcerted signals forming an alphabet, and thereby rendering the instantaneous transmission of language possible, were sent across the sea from Dover to Calais by electric currents through a copper wire insulated by gutta-percha in 1851. The first practical cable was laid in 1852, and now, fifty years after, we have the world embraced and linked together by 200,000 miles of cable, nine-tenths of which have been laid by private enterprise and by British capital. The British Empire is connected up by a nerve system as complete as that in the frame of each human being. In the morning papers we may read at our own breakfast table the previous day's news from our most distant colonies, and from every part of the world. The laying of submarine cables has become such a matter of fact, and excites now so little surprise, that last year 15,000 miles of submarine cable were successfully laid from England, *viâ* the Cape, to Australia without the fact being even chronicled in the daily Press! Compare this with the sensational paragraphs and the gratuitous advertisements so freely promulgated of the so-called "wireless telegraphy." The first Atlantic cable, laid in 1858, was infinitely more wonderful in its conception and completion. Cyrus Field and the men who severally planted down their £1,000 per share to test a gigantic experiment deserve some historical record. They lost their money, but they solved a practical and commercial problem. Of these shares 106 were taken in London, 88 in the United States, 86 in Liverpool, 37 in Glasgow, and 33 in other parts of England—350 shares in all.

A STEP NEARER INTER-PLANETARY COMMUNICATION.

On February 21st, 1894, two years before I met Mr. Marconi, I read a paper before the Society of Arts in London on "Electric Signalling Without Wires." I concluded by saying, "It is something to be able to report that we have now acquired a practical system of signalling across space without the necessity of using wires. Although this short paper is confined to a description of a simple practical system of communicating across terrestrial space, one cannot help speculating as to what may occur through planetary space. Strange mysterious sounds are heard on all long telephone lines when the earth is used as a return, especially in the calm stillness of night. Earth currents are found in telegraph circuits, and the Aurora Borealis lights up our northern sky when the sun's photosphere is disturbed by spots. The sun's surface must at such times be violently disturbed by electrical storms, and if oscillations are set up and radiated through space in sympathy with those required to affect telephones, it is not a wild dream to say that we may hear on this earth a thunderstorm in the sun. If any of the planets be populated with beings like ourselves, having the gift of language and the knowledge to adapt the great forces of Nature to their wants, then if they could oscillate immense stores of electrical energy to and fro in telegraphic order, it would be possible for us to hold commune by telephone with the people of Mars." On December 6th, 1900, paragraphs appeared in the Press with the startling announcement that Mars was signalling to the earth. Light appeared and vanished on the surface of that planet. But the signals could not be read; they were not consecutive or orderly. It is now believed that they were due to natural effects; indeed, to gigantic clouds floating in the atmosphere of the planet reflecting the light of the sun.

I must say something of the history of this fascinating subject.

"WIRELESS" TELEGRAPHY A MISNOMER.

The word "wireless" is an absolute misnomer. Wires are essential and imperative in some part of the plant. It is their position and direction that vary. Every telegraph of every kind requires a transmitter to generate electric disturbances, a medium for their transmission, and a receiver to translate them into comprehensible language. As a medium we may employ, as in ordinary electric telegraphs and telephones, *metallic conductors*, or *air*, or *water*, or the *æther*—the medium that fills all space, whose existence and properties are so difficult to grasp, but which is as real as the walls of our houses. Hence we have a convenient classification:—

1. Metallic Telegraphy.
2. Pneumatic ,,
3. Aquatic ,,
4. Ætheric ,,

Through metals and water the disturbances are transmitted as electric *currents;* through air and the æther as *waves.* In heliography the waves are light waves pure and simple. The transmitter is mechanical and the receiver is the human eye, the most sensitive and beautiful electric apparatus in nature. There is no electricity and therefore there are no wires. It is a real system of Wireless Telegraphy. In Ætheric Telegraphy, or, as the Germans call it, Spark Telegraphy (Funken Telegraphie), the waves are electric, but there is no difference except in size and frequency between them and the light waves formed by every twinkling star. Light waves measure from crest to crest somewhere about $\frac{1}{100000}$ of an inch, but electric waves have a length of from 1 ft. to 1 mile and more. Our great British physicist, Maxwell, established the similarity of electricity and light in 1864. A lighthouse indicates to the mariner its identity by preconcerted groups of light flashes; the heliograph conveys the soldier's despatch from the hill fort by groups of ætheric waves, called light, forming the alphabet; the commander of a fleet directs the movement of every ship by similar flashes of ætheric waves called electric. To comprehend ætheric telegraphy one must know something of waves of light.

EARLY EXPERIMENTS.

Morse, the inventor of the universal telegraphic alphabet that bears his name, showed in 1842, across the Susquehanna, that the water of broad rivers and channels could be made to form part of an electric circuit without submerging any wire in them. Lindsay did the same thing at Dundee across the Tay in 1854, and in the same year I assisted him in testing his plan in London.

The telephone was introduced in 1877, and it proved to be such a marvellous sensitive

Photo by Histed, Baker Street]

SIR WILLIAM HENRY PREECE, K.C.B., F.R.S.

Late Engineer-in-Chief and Electrician to the British Post Office.
(The Latest Portrait.)

apparatus, that it brought to our knowledge minute currents of electricity whose existence was known from Faraday's discoveries, but whose presence was not made evident by any apparatus then extant. In 1882 I succeeded by its aid in bridging the Solent on Lindsay's plan. It is to this day a common practice in India to maintain permanent telegraphic communication across rivers by similar means. Water is thus the medium completing the circuit. The wireless portion is a very small fraction of the whole conducting path or circuit. This circuit conveys *currents* of electricity and the underlying principle is that of *conduction*. In such a system the matter of the earth is an essential element.

THE DISCOVERY OF INDUCTION.

Faraday, in 1832, discovered the principle of *induction*. He showed when iron was magnetised, or demagnetised, that when currents were formed or ceased, even the movements of magnets or of currents, produced, by influence at a distance, other momentary currents of electricity of definite intensity and direction. The medium for the transmission of these effects is the æther. It was known that every telegraph wire, when conveying currents, disturbed every other telegraph wire in its neighbourhood, but the disturbances were not evident. The telephone, however, made their presence known. An old telegraphist in the Telephone Company's Exchange in London, early in 1884, was able to read telegrams being sent on the Post Office system. This led to an immediate investigation. The cause was discovered in Faradaic induction, and the remedy—the metallic circuit—was adopted. This led me at once to the conception of ætheric telegraphy by induction, and to a long and tedious investigation of the possible distance to which these effects were transmissible. Effects were detected between wires separated by a distance of forty miles, and distinct conversation was held by telephone through a distance of one-quarter of a mile. The subject was brought before the British Association on September 7th, 1886, in Birmingham, and has been discussed at frequent intervals ever since.

EARLY APPLICATION OF ÆTHERIC TELEGRAPHY.

In 1892 actual messages were transmitted 3·3 miles across the British Channel, from Penarth to Flat Holm. In 1894 speech was transmitted across Loch Ness 1¼ miles by telephone. In April, 1895, communication was maintained with the Island of Mull during the breakdown of the cable. The system has since been permanently established at several places and has proved itself to be, for short distances, a practical system of telegraphy.

In 1896 Mr. Marconi was introduced to me, and showed me another and better mode of doing the same thing. He had applied "Hertzian" electric waves and Branly's coherer, with which Principal Oliver Lodge had made us so thoroughly acquainted, to the purpose. The resources of the Post Office were placed at his disposal for experiment and trial. During a discussion upon a paper read at the British Association in Liverpool in September of that year upon Hertzian waves, I was able to announce their succesful application to "Wireless Telegraphy" by Mr. Marconi on Salisbury Plain. This created quite a sensation—a sensation that has not yet subsided, for he has very recently, apparently, obtained similar effects by similar means across the Atlantic.

MR. MARCONI'S AMBITION.

Unfortunately, Mr. Marconi was captured by a financial syndicate, and his relations with the Post Office were severed. Nearly six years have elapsed, and yet the system has not yet reached the practical stage. It is still experimental. Mr. Marconi's ambition is evidently to conquer great distances. From Europe to America, and from America to South Africa has attractions for him greater than a good, sound practical system between Guernsey and Sark. It is not wanted across great oceans—it is wanted across narrow, rocky channels, and between tide-swept island homes. It is a remarkable thing to say that at the present there is not a single practical commercial circuit established on this system in the world! It was tried in Honolulu for commercial purposes, but was abandoned owing to its defects. Every nation has warmly taken up the development of the system, especially for their naval services. The British Post Office, the Admiralty, and the War Department are busy experimenting, improving, and testing. Every ship of war is being fitted up, and every colony is watching eagerly for something practical. It was a failure in South Africa. Indeed, it does not work well over land. The sea is its home.

THE SYSTEM IN GERMANY.

Germany, under the immediate auspices of the Emperor, has exhausted every effort to ensure success. Messrs. Slaby and d'Arco have developed a very promising system, which is fitted up on every German warship—forty in all. They seem nearer practical success in that commercial country than the Marconi Company is in England. It is now placed upon the market in Germany, and its services are guaranteed by the Allgemeine Elektricitäts Gesellschaft. There are two systems, one like Marconi's based on the coherer and electric waves, the other based on Hughes' microphone receiver acting as a relay. The latter is said to be more sensitive than the former. The signals are dependent on the variation of current and not of potential. The following appeared in the *Times* recently from the pen of its Berlin correspondent: "The Emperor has published an order to the effect that the Slaby-Arco telegraphic system, the efficiency of which for military purposes has been demonstrated by exhaustive experiments, shall be exclusively employed, until further orders, on board all vessels of the Imperial Navy and in all coast signal stations. The *Post* points out that the Imperial order is of wider significance than is at first apparent, since the commercial marine will also of necessity adopt the system which has been rendered obligatory for the navy. The same journal states that thirty-two German ships of war already possess the necessary apparatus, and that the Hamburg-American line has at Duhner, and the North German Lloyd at Bremerhaven, experimental stations with which telegrams have been exchanged at a distance of 150 kilometres. In engineering circles it is stated that the German Government is preparing a law regarding wireless telegraphy, the object of which is to protect German engineers. The erection of stations after the Marconi system, it is declared, will not be authorised on the German coasts. Mr. Marconi is endeavouring to establish a world monopoly, and the attempt must be frustrated, a task which will present the less difficulty, inasmuch as experts are fully agreed that the Slaby-Arco system is in all respects equal to that of Marconi."

EFFECT OF EXTRANEOUS DISTURBANCES.

Ætheric telegraphy has by no means reached its practical stage yet. It is full of troubles—troubles due to foreign disturbances, to imperfect apparatus, and to want of experience.

The principal source of foreign disturbance is atmospheric electricity and lightning, which set up in the æther electric waves precisely similar in character to those which are being used. In fact, not only is the same kind of apparatus used as a thunderstorm recorder, but when atmospheric electricity is about, letters of the alphabet are received, especially *e*, *i*, and *s*. These currents also break up the conventional signals of the Morse alphabet into an undecipherable language. On many stations in foreign parts the present system installed on our men-of-war becomes absolutely unworkable for several hours during the day, and during last autumn's naval manœuvres each night for three nights in succession the system was unworkable.

How far tuned systems are clear of these disturbances remains to be seen. With a properly fitted up oscillator a train of waves may be sent out by the transmitter, which may act on the receiver only when it is in tune. A train of such waves may be accumulative in its effects. If so, a single impulse would not affect the coherer.

There are terrestrial as well as solar effects which produce disturbing elements in the æther. The extraneous sounds that are occasionally heard in the telephone during the stillness of the night are remarkable. They have been mistaken for the screech of sea fowl and the cry of a baby. Loud whistles, sharp pistol shots, are frequent. These are due to stray waves which are at present fatal to reliable ætheric telegraphy. It is hoped to render them harmless by syntonising or tuning, but no known system of tuning will prevent the sudden inrush of the front of a practically instantaneous intense wave set up by a lightning flash.

SYNTONY AS A REMEDY.

The disturbances caused by neighbouring ships upon each other is perhaps remediable by syntonising, but no real practical system of tuning is yet general. The eye is an electric organ tuned to one series of ætheric waves and blind to all others. We can even tune the eye to receive only one colour. The ear hears all air vibrations between 32 and 5,000 per second and is deaf to all others, and it can also be tuned to hear one note. Similarly, each ship can be tuned to one series or note of electric waves and be quite oblivious to all others. This will render tapping difficult, but it will not remove the much more serious defect of distorted signals. It would have more serious inconveniences with fleets and with signalling stations. There may be some advantage in tuning a private circuit, but syntony would be useless if a vessel in distress wished to communicate with another ship provided with a differently tuned system, and signalling stations would be paralysed if every nation or every shipping company had its own tune.

TO PREVENT A MONOPOLY.

I read in a technical paper that—

> It is stated semi-officially that the Imperial authorities at Berlin are considering a proposal for inviting Great Britain, France, and the United States to send representatives to a congress to be held with the object of arriving at an international agreement which will prevent any monopoly in wireless telegraphy on the high seas. The matter is already receiving attention at the hands of the United States Administration at Washington, and the chief of the Army Telegraph Bureau has been appointed to investigate the proposal and report on its advisability. The incentive for Germany's action in this matter is said to be found in the fact that when the *Deutschland*, with Prince Henry on board, was on her way out from New York, she sent a message to the *Nantucket* lightship (Marconi station) from the Prince for the German Emperor. The Marconi operators, however, refused to accept the message because it was transmitted to them by a Slaby-Arco apparatus.

TAPPING.

Tapping is quite common, but it will probably be diminished with practice and experience. A foreign ship communicating with a consort so affected the electric light circuit of a British ship 800 yards away that every signal could be read by the blinking of the light on one particular electric lamp. This is a puzzle, but it is a fact, and it shows the wide-spread disturbing influence of these ætheric waves. I read in a daily paper :—

> The arrival in Tunis of the French flagship *St. Louis* and the destroyer *Dunois* has resulted in the discovery of a private wireless telegraphic apparatus belonging to a resident. The two ships endeavoured to communicate with the shore authorities, but their messages were intercepted by the instruments of the gentleman in question, who subsequently made himself known, and declared he had fitted up the apparatus with the object of attempting to surprise the messages exchanged between foreign men-of-war, and particularly the British.

On the other hand, the Cunarder *Umbria*, which was following the *Philadelphia* across the ocean at only a day's steaming, was so tuned that she did not receive any of the signals which were flashing over her.

The very powerful induction coils that produce the sparks needed, disturb not only the receiver, but the magnetic compasses of the ship, and even the chronometers. This has to be very carefully watched and guarded against by keeping the apparatus as far away as possible, and by screening.

CABLE v. ÆTHERIC TELEGRAPHY.

Whatever æthenic telegraphy may be in the future, it is not at present a practical, reliable, and commercial system. The scientific facts of æthenic telegraphy are quite triumphant, but up to the present its practical results are poor in the extreme. The sensational and really wonderful results across the Atlantic have had an absurd influence on cable stocks in the Money Market. Shareholders, especially of the feminine gender, have been panic-stricken, and have transferred their depressed property to wiser pockets. The value of the submarine cable system has not been shaken one iota. The Atlantic ocean is bridged by fourteen cables always available and rarely disturbed. Each works at a speed far exceeding anything obtainable on an ætheric circuit. Fifteen ordinary words a minute is a high rate of working on such a circuit for short distances, say up to fifty miles, twelve words is about the rate in Germany, but I do not anticipate in practice a normal rate of more than ten words a minute.

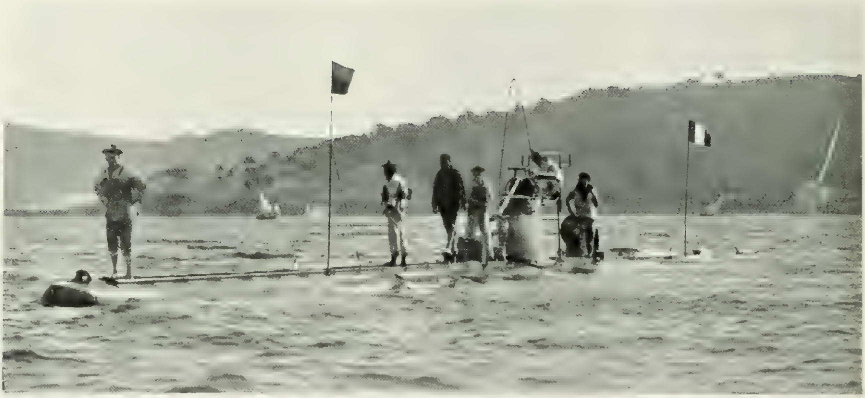
MARCONI SIGNALS NOT ENCOURAGING FOR ACCURACY.

The speed of working is limited by the number of sparks that can be passed per second, and the greater the quantity of energy in the spark the fewer that can be passed in the same time. Moreover, sparks are very capricious things and require much humoring. The signals received by Mr. Marconi are not encouraging for accuracy. Cable messages average nine words each, of which three are service words and six are paid for. They are code words which are very unsuitable for ætheric telegraphy just now. With repetitions, corrections and fatigue, it is impossible to calculate upon getting more words through a cable than 50 per cent. of the maximum carrying capacity of that cable. What percentage will an ætheric circuit carry?

Wireless telephony has received very little attention, for it is confined to short distances. I read a paper on the subject at the British Association meeting in Bradford on September 10th, 1900. Communication was established with the lighthouse at the Skerries and Cemlyn in Anglesey and continues.

No one for one moment can, or ever has, doubted that ætheric telegraphy is invaluable for nautical purposes. The demonstrations which the English and German experimenters have been allowed to carry out on the great Atlantic liners, have placed this beyond cavil. It tends to render the navigation of the great deep safer, it places ships in communication with each other when in danger or distress, it prevents collision in fog or at night, it allays the anxiety of the passenger, and it gives confidence to the sailor.

The awakening of the Press to the wonders of scientific progress has spread a sensation throughout the land. Calm judgment has been shaken. It is wise that we should reflect. There have been greater wonders in the past which were not received with the same fervour. The telegraph, submarine cable, the telephone, the phonograph, photography, &c., did not shake men's faith as this "Wireless Telegraphy" has, nor cause the memory of previous successes and previous sensations to be so soon forgotten. The Press of 1892 was quite as wild over the Post Office success to the Island of Mull as it is now over Marconi's triumph across the Atlantic.



THE "GUSTAVE ZÉDÉ."

The longest Submarine in the world. She is driven solely by electricity derived from accumulators. Her horse power is 720, and displacement when submerged 266 tons. She has often figured in naval manœuvres in France.

SUBMARINE BOATS.

BY

HERBERT C. FYFE.

The following article speaks of the history and development of submarine boats. The illustrations are, for the most part, engraved from original photographs, and now appear for the first time.—Ed.

LOOKING back over the history of submarine boat construction, which commences with the building, in 1795, by David Bushnell of the first practical submarine boat, and the first of which any detailed account is extant, one cannot fail to be struck by the fact that so few Britons have devoted their energies and their talents to the building of vessels for sub-surface navigation.

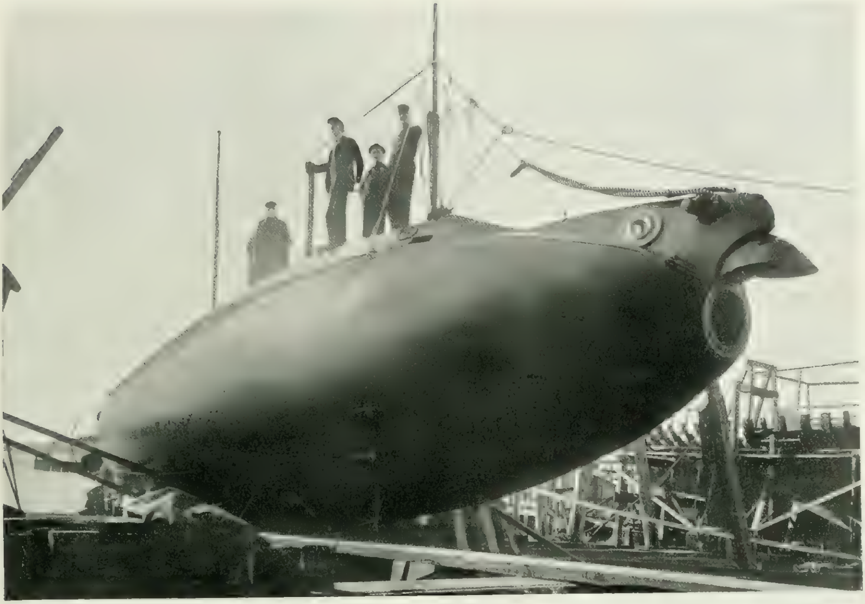
In the story of locomotion both on land and on sea, British names are well to the fore, but for some reason or other the questions of submarine and aërial locomotion have appealed much more strongly to the minds of Americans and Frenchmen.

THE EARLIEST SUBMARINES.

The two earliest constructors of submarine boats, David Bushnell and Robert Fulton, were Americans. It was during the American Civil War that there occurred that famous incident, the blowing up of the Federal corvette, *Housatonic*, by the Confederate diving torpedo boat, *David*, and while hostilities lasted each side devoted a good deal of attention to underwater warfare.

After the war the subject was not lost sight of in the United States, and the persistent efforts of Mr. John P. Holland led to the purchase by the Government of the *Holland* in 1890.

France, ever since the year 1886, has been



"VERY LIKE A WHALE."

The "Fulton" just ready for launching. She is similar to the first five British submarines and has made several lengthy journeys and fired torpedoes whilst in motion.

keenly interested in submarines, and numerous French inventors have devoted years of toil to the perfection of these craft.

The number of English engineers who have attempted the construction of submarine boats is exceedingly small, and it is doubtful if we can even claim Mr. Nordenfeldt as an Englishman. When Fulton was making some experiments before Pitt, who was rather pleased with his ideas, Lord St. Vincent, then First Lord of the Admiralty, made his famous remark: "Pitt was the greatest fool that ever existed to encourage a mode of war which those who commanded the seas did not want, and which, if successful, would deprive them of it."

BRITISH OFFICIAL ATTITUDE.

Though ungrammatical, his lordship's remark serves to explain the official attitude in Great Britain towards all methods of submarine attack and defence. In view of this attitude it is not strange that so few should have seriously taken up the subject in this country. During the last few years, however, the British Admiralty have been forced to rearrange their ideas. The addition of practical submarine vessels to the navies of France and the United States makes it imperative for Great Britain to guard herself against the new menace and to consider the advisability of adding similar craft to her own navy.

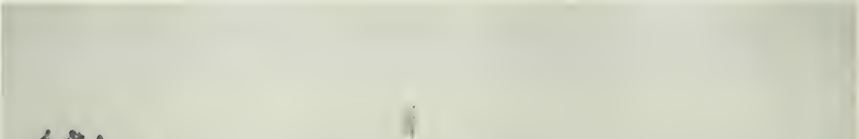
FIVE HOLLAND BOATS ORDERED.

In the autumn of 1900 five of the newest Holland boats were ordered from Messrs. Vickers, Sons, and Maxim, the European agents of the Holland Torpedo Boat Company. Mr. Arnold Forster explained to the House of

THE "NARVAL."

The first French submarine to be fitted with two methods of propulsion: a steam engine (fed by liquid fuel) drives her on the surface, and an electric motor beneath the waves. She has a double hull; her length is 111 ft. 6 in., and displacement when submerged, 200 tons.

Commons last January, that when the decision to construct submarine boats was arrived at only one type was available for purchase. The right to build boats of this type was in the hands of one firm, and it was therefore necessary to entrust the work to that firm. Whether the Admiralty would not have been better advised to have requested designs from different shipbuilders in this country, and to have ordered five experimental vessels of different types, is a question which it is not necessary to discuss here. The five Holland boats were ordered, and they are now in the water. The dates of the launchings at Barrow



A SUBMARINE TAKING THE WATER.

One of the newest American Holland boats, the "Shark," being launched. She is similar in almost all respects with the first five British submarine vessels.

are as follows: "No. 1," November 2nd, 1901; "No. 2," February 21st; "No. 3," May 3rd; "No. 4," May 23rd; "No. 5," June 10th, 1902. These five boats are identical in almost all respects with the six ordered for the United States Navy in 1901—viz., *Pike*, *Adder*, *Porpoise*, *Mocassin*, *Grampus*, and *Shark*. The *Fulton* is an experimental vessel similar to these six, and owned by the Holland Company.

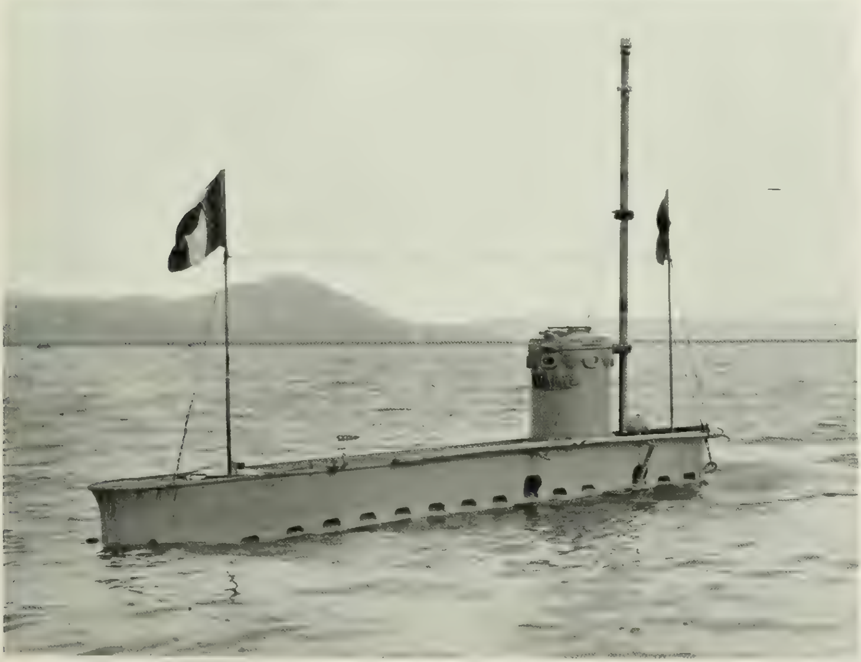
ADDITIONAL SUBMARINES.

The Navy Estimates for 1902-1903 provided for four further submarines, and the Admiralty are proposing to continue the process of adding submarines to our fleet, Mr. Arnold-Forster having stated that the new boats will be an improvement on those already constructed at Barrow. The new vessel, launched on July 9th from the yard of Messrs. Vickers, Sons, and Maxim, is the joint invention of this firm and the Admiralty. It is believed to have better sea-keeping qualities than the first five boats, to have a wider radius of action, and to be capable of acting with a fleet on the offensive.

SUBMARINE BOATS ABROAD.

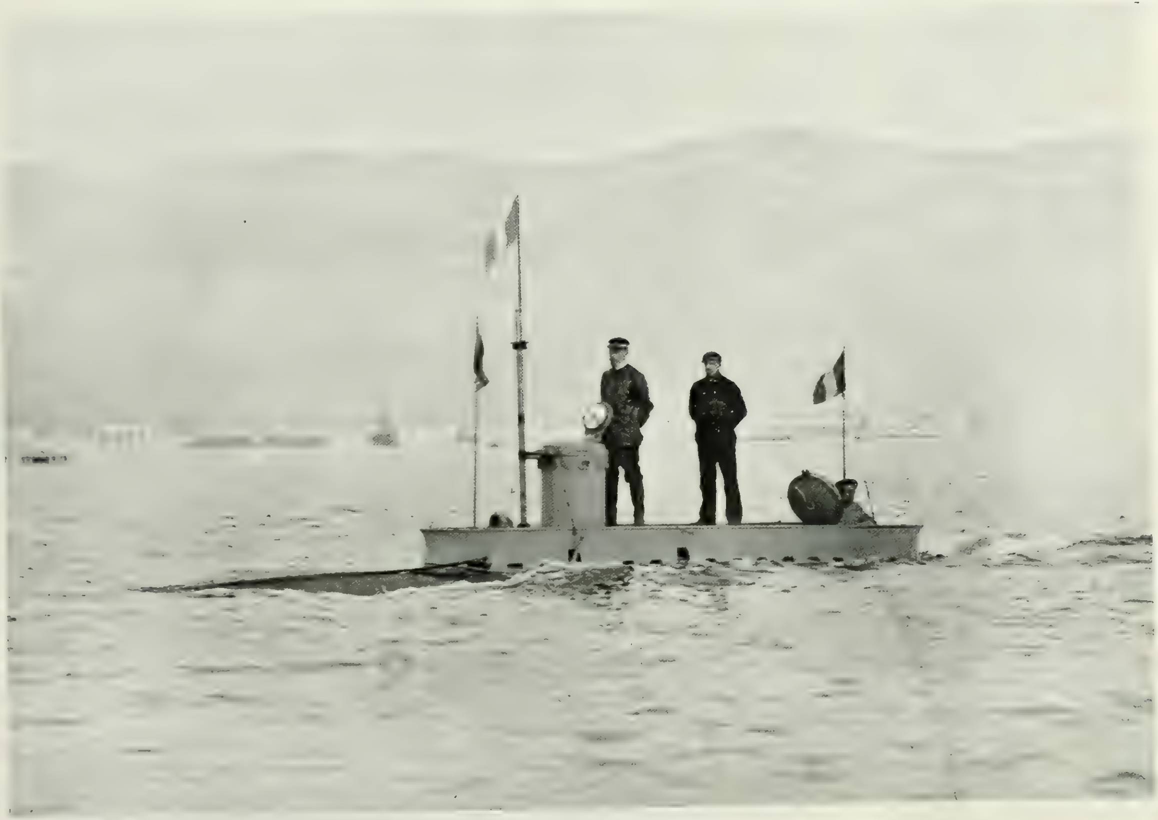
The Naval Committee of the United States Senate have just amended the Appropriation Bill, and have provided for the purchase of five further submarines of the newest Holland and other types.

Turning now to France, the only other nation that has seriously taken up the construction of submarine war vessels, we find that, if the present programme is adhered to, the French Navy should, by the close of 1906, be in the



THE "GYMNOTE."

She was the first submarine added to the French Navy, and is now used as an instructional craft. She depends solely on electricity for her motive power, and is now regarded as an obsolete type of craft.



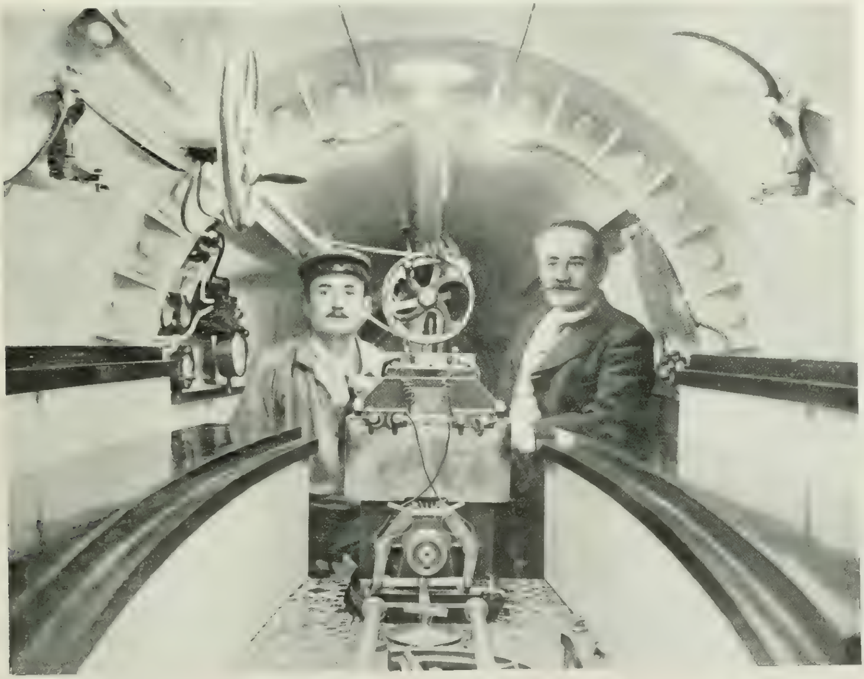
THE "GYMNOTE" AFTER A RUN UNDER WATER.

When first tried she was very erratic, and her crew often suffered severely from her unstable motions possession of a submarine flotilla numbering sixty-eight vessels.

For the purposes of comparison it may be interesting to take some of the newest boats and consider their characteristics and peculiarities. We may choose the newest Holland type, the *Fulton*: the newest French submarine proper type (*i.e.*, propelled solely by electricity), the *Morse*; and the newest French submersible (*i.e.*, propelled on the surface by a steam engine and underneath by electricity), the *Narval;* and, finally, the type invented by M. Goubet.

METHOD OF SUBMERSION.

All of these boats are capable of manœuvring as surface craft when in the "light" condition —*i.e.*, with ballast tanks empty, and they differ from the Whitehead torpedo (in reality, a crewless submarine), which immediately on being fired sinks beneath the surface, and remains beneath during the whole of its run. The first point, then, to be considered is the method of submersion. In the *Fulton*, *Morse*, and *Narval* the same plan is employed. The first operation is the admission of a certain amount of water into the ballast tanks in order to bring them to the "awash" condition—*i.e.*, with only the conning tower above water and with about three to five inches of water between the hull and the surface. In this condition the boat may, of course, be navigated, using her electric motor, and when it is desired to totally submerge her she is steered below the surface by means of



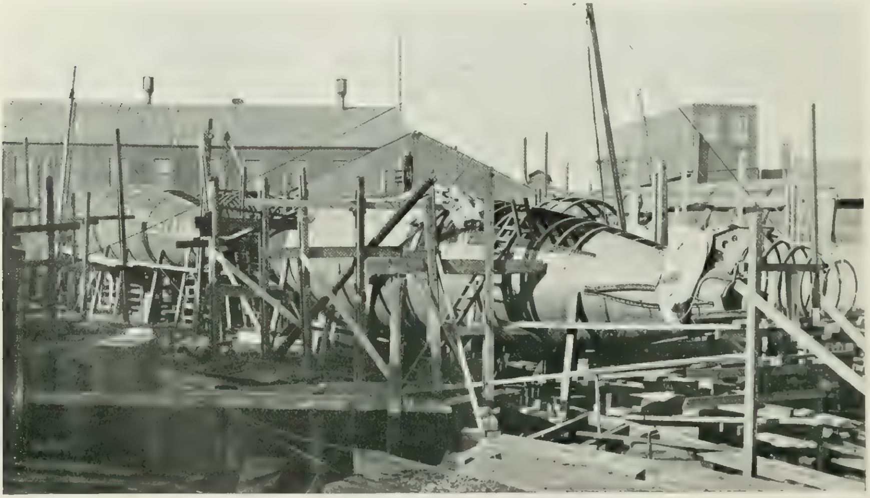
INSIDE THE NEWEST GOUBET SUBMARINE.

M. Goubet the inventor and a mechanic in the interior. A type of craft intended to be hoisted on shipboard and carried to the place of action This is from the only photograph ever taken *inside* an underwater vessel when submerged horizontal rudders. In certain details the boats differ from one another. Thus the *Narval* class have double hulls, and some of the water tanks are placed between the two skins ; in the other types the tanks are all carried in the interior, there being only one skin. Then, again, the disposition of the horizontal rudders varies. In the Holland they are always at the stern. In the *Gustave Zédé* there are six diving rudders carried on the sides, two forward, two in the centre, and two aft. The *Narval* and *Morse* have each four side rudders, two forward and two aft.

The *Fulton*, *Morse*, and *Narval* have all a reserve buoyancy when submerged. The *Goubet*, however, belongs to the class which have no reserve buoyancy when under the water. Having been brought to the "awash" condition, the *Goubet* is sunk by the admission of a further quantity of water, and when she is running submerged, her total weight exactly equals the weight of water she displaces. In the other three types the weight is less than the weight of water displaced.

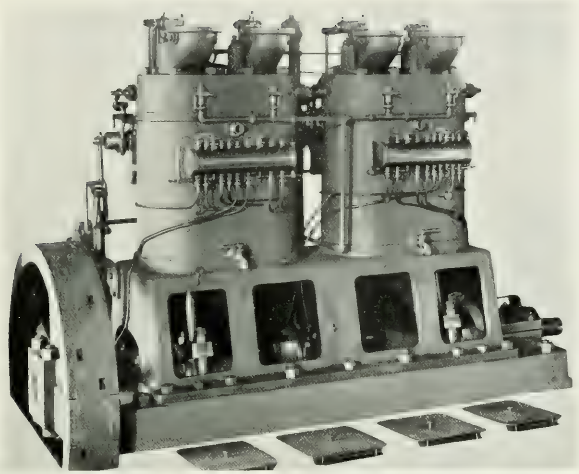
M. GOUBET'S BOATS.

The advantage of the "positive floatability" type over the "negative floatability" type lies in the fact that if anything goes wrong the former will at once rise to the surface. M. Goubet's boats are miracles of ingenuity, but they are tiny craft, and it is doubtful if, built on a larger scale, they would behave as well as they are said to do now. Even as it is, a glass of water added to the tank will—so it is reported—upset the stability of the craft. In all these vessels submersion is effected by the alteration of weight. It is also possible to effect submersion by the alteration of the volume of displacement, though keeping the weight constant by withdrawing "plungers," "cylinders," or "drums," which protrude when the vessel is floating at the surface. The first inventor to employ the latter method was André Constantin, who built a vessel during the siege of Paris, which was furnished with pistons working in two cylinders. On these being drawn in from the interior, the boat sank (theoretically) to the



SUBMARINES ON THE STOCKS.

Some of the newest American Holland boats under construction at Elizabeth Port, New Jersey, U.S.A.



THE OTTO GASOLINE ENGINES OF THE NEW BRITISH SUBMARINE BOATS, NOS. 1-5.

required depth. The actual trials were, however, not satisfactory.

THE NAUTILUS TYPE.

The *Nautilus*, of Messrs. Campbell and Ash, was submerged by alteration of displacement. Five cylinders were provided on each side of the vessel opposite to one another, so that they could be worked in pairs; the displacement could thus be varied by one or more of these pairs of cylinders being pushed out beyond the side to increase, or drawn in flush to decrease, the displacement.

The *Nautilus* underwent some trials in Tilbury Docks in 1888, and she sank with Sir W. H. White, late Chief Constructor to the Navy, and others on board. Unhappily, she went right down to the bottom and stuck in the mud, and the cylinders declined to out-thrust, because the power for working them, though amply sufficient for working in water, was not great enough to drive them in the mud, and the inventors had not taken into consideration the adhesiveness of mud. On Sir W. H. White's suggestion, those inside the vessel moved to the higher end of the craft, and the boat was lifted from the grip of the mud. The *Nautilus* type has not found favour with engineers, and has now passed into the limbo of forgotten failures. As Sir William White has pointed out in his "Manual of Naval Architecture," the weight of the vessel and its contents must be made to slightly exceed the weight of water displaced by the total volume of the vessel. This excess in weight causes a downward motion, rapidly accelerating unless checked; and the control of the descent so as to limit it to a specified depth is not easily affected by appliances which simply vary the displacement.

The submarine craft constructed by Mr. Thorsten Nordenfeldt belonged to the positive floatability type. They were brought to the "awash" condition by the admission of water ballast, but, instead of being steered below the surface by horizontal rudders, as are the *Fulton*, *Morse*, and *Narval*, they were sunk by means of propellers working in vertical shafts. In the first boat the propellers were fitted inside sponsons, but in the later ones they were placed in the fore and aft lines. Mr. Nordenfeldt did not believe in steering submarines down an inclined plane, and all his boats went down on an even keel. Thanks to recent ingenious contrivances, it is now quite simple and safe for a submarine to descend by steering downwards and all modern craft go under at an angle. There is one other method of submersion and that is to admit a certain amount of water and then to force the boat below by shifting a heavy weight, or weights, forward.

PRESERVING LONGITUDINAL STABILITY.

Having now discussed the various methods of sinking submarines, the question of preserving their longitudinal stability must be considered.

The *Fulton*, *Morse*, and *Narval* are lighter than the water when submerged, whilst the *Goubet's* weight equals its displacement, and the tendency of all these boats on the slightest provocation is to rise to the surface or sink to the bottom. The principal causes of disturbance have been summed up by Captain Hovgaard, in a paper entitled "The Motions of Submarine Boats in the Vertical Plane," read before the Institution of Naval Architects at the Annual Meeting in 1901:—

(1) Faulty use of horizontal rudder. (2) Admission of water through leakages. (3) Expulsion of foul air and products of combustion. (4) Firing of torpedoes and projectiles. (5) Movements of crew. (6) Existence of free surfaces of liquid. (7) Movements of loose weights such as fuel. (8) Variations of buoyancy caused by varying density of sea-water. (9) Grounding and collision. (10) Variations in speed. With regard to the firing of torpedoes, the *Fulton* type carry four compensating tanks, and as the torpedoes are fired water is admitted into these. Thus the stability of the submarine is preserved. As to (5) those who have had personal experience of travel in the Nordenfeldt boat report that when a greaser walked forward a couple of feet in the engine-room the head would go down a little, the water would surge forward in the tanks, and she would plunge to the bottom unless checked in time. The Whitehead torpedo is kept at a set depth below the surface during its run by means of the combined movements of a hydrostatic valve and a pendulum, which by the aid of a "servo-motor," incline the horizontal rudders in the required direction. The movements of the submarine may be controlled either by the movements of the horizontal rudders or by the shifting of weights from aft to forward or *vice versâ*. In the *Fulton* type three trimming tanks are provided—one forward, one centre, and one aft—and these all help to preserve the longitudinal stability of the vessel.

The system employed by M. Goubet for the attainment of this end is as follows: At each end of his vessel is a large circular water-tank connected by a stout pipe, in the centre of which rises a pear-shaped dome containing a pendulum, a rotary pump, and pipes connecting the two tanks. When the submarine shows a tendency to rise to the surface or to dive to the bottom, the pendulum swings forward (marking the extent of the deviation on a dial above the dome) and in so doing forms a connection between the motor and the accumulators; the motor then commences to work the rotary pump, and the water is pumped from the higher tank to the lower until the boat is brought to the level position again. The pendulum then swings straight and the electric current is cut off and the motor stops.

MOTIVE POWER.

The question of motive power need not detain us long. Every modern submarine is driven by an electro-motor fed by accumulators when running submerged, and until great improvements have been effected in these it is impossible to hope for much greater speed. Doubtless the accumulator of twenty years hence will be much lighter and much more powerful than are those of to-day. As to surface propulsion, the gasoline engine used in the *Fulton* type appears to give satisfaction, and if submarines are to increase in size, larger gasoline engines would probably propel them at higher speeds than are attained at present. The four-cylinder gasoline engine carried in the *Fulton* is rated at from 160 to 190 actual horse-power, and at from 320 to 390 revolutions per minute. Its net weight is 1,300 lbs., its length over all is 9 ft. 7 in., and its total height above the crank shaft centre is 5 ft. 6 in. In these engines the distribution of he cranks and the timing of the valves and gniters are so arranged that the operations in he four cylinders alternate, so that while one is at the expansion stroke, the other three are at the suction, compression, and exhaust strokes respectively. By this arrangement the engine is perfectly balanced, and vibration is reduced to a minimum.

VISION WHEN SUBMERGED.

Those who condemn the submarine boat because it is blind when beneath the waves are apt to forget that the modern craft is in reality a torpedo-boat, whose usual place is on the surface, but which is capable of sinking entirely out of sight for brief periods to fire torpedoes, to escape detection, and avoid the fire of the enemy's quick-firing guns. When in the "awash" condition the submarine is steered from the conning tower, and when running thus she would be a very difficult object to hit. Having approached within a certain distance of her prey she would disappear, perhaps rising once for a second to take final bearings before launching her torpedoes. With regard to instruments for under-water vision it is difficult to gauge the value of these until they have been put to a practical test during manœuvres or in actual warfare. Some of the French submarines have, according to the French service papers, torpedoed ironclads, steering solely by the aid of their optical tubes and periscopes; but in bad weather and in the storm and stress of a naval engagement it would be difficult to make much use, one would imagine, of such aids to vision. If the submarine can rise quickly, take observations rapidly, and dive with celerity, it is not likely to run the risk of being "stuck" by the spar torpedo of a swift destroyer. The optical apparatus employed in the British submarines is the "hyphydroscope," the invention of Sir Howard Grubb, F.R.S.

THE FUTURE OF THE SUBMARINE.

The submarine boat is to-day very much in the same position as the Whitehead torpedo and the torpedo boat in the first stages of their development. The early Whiteheads had a speed of from 7 to $7\frac{1}{2}$ knots, a range of 1,000 yards, and a charge of 67 lbs. of gun-cotton, and they were exceedingly erratic in their behaviour. Now they have a speed of over 30 knots, and their range is 2,000 yards, their charge 200 lbs., of gun-cotton, and thanks to the gyroscope hydrostatic valve and pendulum, they can be run absolutely straight up to 2,000 yards.

The *Lightning*, the first torpedo boat constructed by Messrs. Thornycroft, is a very poor affair when contrasted with a *Viper* or an *Albatross*, and as the torpedo and the torpedo vessel have developed so it is likely that the submarine boat will develop, and that the under-water craft of fifty years hence will be vast improvements on those of to-day.

As a weapon of defensive warfare the submarine has already shown its value, and it has probably rendered close blockade impossible. As a weapon of offence there is still room for great improvement. Its sea-keeping qualities will have to be improved and its speed increased before it will be capable of acting with a fleet. French submarines have, it is true, made long journeys and torpedoed vessels at a considerable distance from their "base," and during the coming summer there are to be combined manœuvres of French submarines along with torpedo craft against the battle squadron. These will be watched with interest by those who believe in the "coming of the submarine." A syndicate has lately been formed to take over the Goubet patents, and there are those who argue that the small craft could be hoisted on board battleships or in "mother-ships" and conveyed to foreign waters; on the other hand, many naval officers view the arrangement with distrust.

DETAILS OF BRITISH SUBMARINES, NOS. 1—5.

Length, 63 ft. 4 in.
Beam, 11 ft. 9 in.
Displacement submerged, 120 tons.
I.H.P. surface, 160.
I.H.P. submerged, 70.
Speed surface 8 knots.
Speed submerged, 7 knots.
Radius of action surface, 400 knots.
Radius of action submerged, 28 knots.
Armament, 5 Whitehead torpedoes.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

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Telephone No. 3340 GERRARD.

Telegraphic and Cable Address: "SINEWY, LONDON."

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OUR MONTHLY RÉSUMÉ.

LONDON, 20th July, 1902.

Shipping and Shipbuilding.

THE columns of the daily newspapers continue to be filled with a great deal of foolish and ill-digested matter relative to the shipping interests of the country. Combines are in the air, and America is on the brain, in certain journalistic circles. It is not worth while to discuss the various stories of further organisations among shipping companies, for all are imaginary, and most of them are obviously absurd. Some re-organisation in the Anglo-Canadian service is being negotiated. The Cunard Company are engaged in some design for improving their own and the British position generally on the North Atlantic, and the Royal Mail Steam Company are negotiating an alliance with other lines in the West Indian and South American services. But, while we write, all these projects are in a nebulous condition, and are, therefore, only mentioned as possibilities. As to the various projects headlined in the evening papers, we do not refer to them, because they are impossibilities. Meanwhile, the shareholders of the German companies have confirmed the agreement with the Morgan Combine, and it is to be observed that this agreement was recommended to their acceptance as one "purely commercial in its nature," and to their own material advantage. So much for the bounce about the "patriotism" of the German companies in preserving a national independence which was never threatened. Herr Ballin insists that the German companies lose nothing by agreeing not to touch at Belgian ports—and perhaps he is right.

Shipping Subsidies.

Next to Combines and rumours of Combines the most noteworthy incident in connection with British shipping has been the re-commencement of the inquiry into shipping subsidies by the Select Committee of the House of Commons. There was a rather unreasonable attempt to prevent the re-appointment of this Committee, on the ground that last year it devoted its attention too much to the interests of British shipowners. This was a very unjust view to take of the case. It is true that some of the shipowning witnesses whose evidence was heard last year advocated subsidies, but others were as strongly against them, and the Committee expressed no opinion either way, nor can do so until its work is completed. A good deal of surprise has been created by the evidence of Sir Robert Giffen, one of the first witnesses examined by the re-appointed Committee. Sir Robert seems to be shaken on his bed-rock of orthodox economics by the Morgan Combine, and to be disposed to cry "Thus far and no farther." He says that if foreign Governments are determined to have a larger share of the shipping industry than they ought to have, we should be prepared to fight the matter out. "The Government ought not to shrink from running ships on certain lines to bring goods for nothing to English ports, so as to extinguish and make unprofitable the unfair competition. By levying a duty upon all goods imported from the countries concerned, they would cover the cost of running free ships. It would not matter to the consumers, whether they paid the cost of carriage of the goods to this country in the form of prices including freights, or in the form of duties charged by the Government in lieu of freight to pay for the cost of ferrying across."

Our View.

This is rather "tall," and so far as we have been able to test, the opinion is not endorsed by shipowners generally. The idea of the Government running free ships is rather wild, but there is undoubtedly a great deal to be said in favour of subsidising, to a moderate extent, lines of steamers to provide inter-communication between widely separated parts of the Empire which have not enough reciprocal trade to make a service remunerative to private enterprise. The subventions in such cases should be just sufficient to pay a reasonable rate of interest on the capital invested and to afford margin for upkeep. And in return the ships should be bound to carry the Imperial and inter-colonial mails and perform any other Imperial service that may be required On this principle there might be regular steam communication between the East and the West Indies, between Canada and Australia, between West Africa and the West Indies, between the Cape and Ceylon, and so on. It is not difficult to believe that such subsidised lines may in time serve to create a remunerative stream of traffic, for it is often true that supply creates demand; but, at any rate, a high Imperial service would be rendered in bringing all the widely separated members of the Empire into regular and direct communication. Then, *pace* the Cobden Club and economists of the Manchester School, a great deal is to be said in favour of reviving some portion of the old Navigation Laws. It is, to put it mildly, not fair for America and other countries to have free access to our coasting and colonial trades and to shut us out from theirs. A voyage from New York to San Francisco, round the Horn, is accounted a "coasting voyage" in the meaning of the Navigation Laws of the United States, and British vessels and all foreign vessels are excluded from it. But American vessels can come and trade all round the British Isles, from port to port, as freely as British vessels. But should we not call a voyage from Montreal to the Cape a coasting voyage reserved for our own vessels? At any rate we can, and should, refuse to admit into our coasting and colonial trades the vessels of all countries which refuse to allow our vessels into their trades. If we passed such a law not one single nation could retaliate. It has been suggested that if we did so the United States might shut us out of their foreign trade. If so, there are not enough vessels in the world, outside the British register, to carry the produce which the United States must get rid of, and to bring in the goods they must import.

The American Shipbuilding Combine.

Of course, it may be said that the Americans can soon build up a mercantile marine for themselves, and that they are bent on doing so. "Soon" is a relative term, and ability is not always equal to desire. That America will be a great shipbuilding and shipowning country some day we honestly believe but it will take a long time yet. The report of the formation of a great American Shipbuilding Combine has caused some commotion among the aforesaid emotional and ill-informed journalists, but what does it amount to? The Combine includes some five or eight (the latter figure is stated, but only five concerns have been named) shipbuilding yards in Maine, New Jersey, Virginia, Delaware, and California. This wide distribution does not make for effective management, though it may be freely admitted that the Combined yards are among the most perfectly equipped yards in America, and, perhaps, in the world. But they have been principally engaged in warship-building, and their plant is not adapted to the economical production of ocean merchant steamers, especially those of the "tramp" class, which do the bulk of the carrying trade of the world. This Combine starts with a capital of some £7,000,000, with which the five or eight yards have to be acquired, and a big graving dock constructed on Staten Island, while £3,000,000 will be devoted to the purchase of the Bethlehem Steel Works for the supplying of new material to the several yards. And with this comparatively small capital the Combine boast that they will "invade the shipbuilding markets of Europe." The idea is preposterous. Their whole power of production will not exceed that of the Clyde shipyards alone.

"Would take 172 years."

There are some forty-four establishments in the United States engaged in the building and repairing of iron and steel vessels, with an aggregate capital of £12,000,000, and employing some 30,906 men. (We draw from the census report of 1900.) The output from these yards of vessels suitable for the foreign trade was in 1900 only 29,069 tons. The entire output of vessels for the foreign trade from American yards in the ten years ending 1900 was only 206,771 tons. All the rest of the building was for the coasting, Great Lakes, and river trades. During the ten years the loss off the American register by wreck, old age, breaking-up, etc., was 461,631 tons. That is to say, the wastage of American tonnage in the ten years was more than twice as much as the output in the United States of new tonnage suitable for the foreign trade. The cost of building is, as has been shown over and over again, from 30 to 40 per cent. more in the United States than in Great Britain. It is calculated by American experts that at least 5,000,000 tons of vessels would have to be added to the register to enable America to carry all her own foreign trade. At the rate of production of 1900 it would take the American yards 172 years to provide that tonnage. It would take them eight years to make up one year's wastage at the present rate. According to Lloyd's latest returns there are at present 29,628 vessels of registered tonnage in the world, of an aggregate of 32,437,763 tons. Of that total Great Britain has 15,546,897 tons, practically all of which is suitable for ocean (foreign) trade. America has 3,337,156 tons, of which less than 900,000 tons is suitable for the ocean trade. There is not much cause for alarm in these figures.

The Competition of Electrical Manufacturers.

It is confidently asserted that the competition among electrical manufacturers which prevails at the present moment has no parallel in electrical history. During the very worst days of the struggle for supremacy in the United States it is doubtful whether there was keener fighting or more severe cutting in prices than exists in this country at the present moment. It is true that the struggle is mainly confined to four or five firms, but these do not represent by any means the whole of the electrical industry, and one is curious to know what the position of the smaller firms is likely to be during the next twelve months. Even if the fight among the giants continues it is bringing little grist to the small mill, and in the event of a combination or even an arrangement among the large firms, the small manufacturer is likely to be squeezed out. It is true that there must be a considerable amount of non-competitive business, but in this again the best known and most active firm is likely to make the heaviest score. For the industry as a whole the outlook is by no means bright, and this notwithstanding the enlarged field in which electricity operates.

The Strangling of the Electrical Industry.

Some reference was made in our last issue to the action of the Institution of Electrical Engineers in approaching the Government on the subject of electrical legislation. In pursuance of this active policy the officials of the Board of Trade have been interviewed by the President of the Institution and a strong deputation, who were able to demonstrate conclusively that many of the present rules and regulations governing the supply of electricity are altogether behind the times. It must, we think, be patent to the most casual observer that electrical legislation as it stands to-day is proving a serious obstacle to the adequate development of commercial electricity. One need not be an opponent of municipal enterprise to declare that when our legislators framed laws concerning electricity supply, they had the municipalities foremost in their minds. There may have been some justification for such an attitude in the state of electrical industry at the time, but in the impending development of electricity as a cheap universal power, the municipalities can play no part. In saying this we are neither condemning municipalities nor approving of power schemes as a whole. It has been clearly established that it is possible to supply cheap electrical power over vast areas; and in the light of this paramount fact the question merits the renewed consideration of Parliament, and a freedom from hampering regulations.

The Municipal System.

Parliamentary Committees have recognised the growing possibilities of the industry by a lavish liberality to most power schemes, but no important development can be expected until the absolute powers of the municipality have been to some extent diminished. Wherever a municipal system is jeopardised by a power scheme it is the obvious duty of the local authority to protect its undertaking; but when it is in the power of any small local authority to veto and destroy the utility of a scheme which aims at supplying electricity over a wide area, it is certain that harm may accrue both to the electrical industry and the country. Thus there is ample justification for a complete overhaul of electrical legislation, and it is to be hoped that the new Bill which the Board of Trade propose to bring before Parliament will do much to modify the present onerous conditions. For many reasons there is just now a glut of electrical schemes in the market, and as some of them would scarcely earn sufficient revenue to pay for fuel, it is not surprising that financiers are inclined to leave them severely alone. The unfortunate effect of this is that good schemes are apt to be classed with poor ones, and as there is enough reason to apprehend a period of stagnation from this cause alone, it becomes doubly important that the electrical industry should not suffer any longer from effete legislation.

Combined Lighting and Tramway Systems.

The question of separate or combined lighting works has been worn nearly threadbare, but this fact ought not to prevent the recognition of any new and direct evidence on the subject. Mr. J. H. Rider, in his recently delivered presidential address to the Municipal Electrical Association, quotes some figures as to the actual economy of combined works, which are worth the attention of the most ardent advocate of separate systems. For the purpose of comparison, a purely lighting system and one combining both lighting and tramways is taken, and the results strongly support the views of those favouring combined generating plant. The lighting system had a larger lamp connection, as is seen from the following table:—

	Combined Lighting and Tramway System.	Lighting System.
8 c.p. lamps connected	90,057 ...	130,550
Units sold for lighting	1,121,069 ...	1,490,000
Units sold for tramways	1,999,640	——
Average price obtained for lighting... ...	3·41d. ...	3·83d.
Average price obtained for tramways ...	1·5	——

Yet in spite of the larger lamp connection and the higher price obtained per unit for the lighting system, the financial results are vastly inferior to the other. The lighting system has a deficit for the year of £2,783, with a total cost per unit of 2·35d., while the lighting and tramway combination has a surplus of £4,752, and holds the record with a total cost per unit of ·96d. It would be idle to deny that these results have been in a great measure due to the tramways, and we think that municipalities might learn a very valuable lesson from them.

A Warning on Conduits.

From the peculiar position he occupies as electrical engineer to the London County Council, Mr. J. H. Rider's views on the subject of conduit tramways are worthy of the most serious consideration, and it is to be hoped that those authorities who are coquetting and experimenting with various surface contact and open conduit systems will carefully bear them in mind. In any case, London's example could be followed with profit by few towns, for in the metropolis the short headway between the cars might go some way to combatting the very heavy expense entailed in a conduit line. The President of the Municipal Association is especially severe in his remarks on hybrid systems, and condemns in unmeasured terms combined overhead and conduit schemes.

A New Gutta-Percha.

An invention of far-reaching importance to the electrical industry has recently been perfected after over ten years of experiment and testing on the part of the inventor and of several important authorities.

The material is practically gutta-percha synthetically produced, and, while possessing all the electrical and mechanical characteristics of natural gutta percha, it has the important advantage of a softening point, which is some forty or fifty degrees higher than that of the natural gutta-percha.

Having regard to the growing scarcity of natural gutta-percha, and to the fact that, owing to the large and increasing demand for it, the gutta-percha of to-day is very inferior in quality to that which was sent to this country thirty years ago, the introduction of a material the analysis of which is practically the same as natural gutta-percha, and which can be sold at some reduction on the present price of the natural material, should have a great future before it. We shall hope to revert to this material in greater detail in a future issue.

Superheated Steam.

Some interesting results have recently been obtained by the use of superheated steam in locomotives and marine engines. A series of trials on a practical scale were carried out by the Canadian Pacific Railway from September 22nd to November 9th, 1901. The engine working the superheated steam was compared with a similar engine worked with ordinary steam, and with a compound locomotive. The total weight of engine and tender in each of the three cases was the same. The tonnage hauled was practically the same, and the results were as follow :—

Particulars	Type of Locomotives.		
	Simple with Superheater	Simple.	Compound.
Equivalent ton miles hauled	27,965	17,384	21,400

From this it will be seen that the performance of the simple engine with superheater was 60·9 per cent. better than a similar simple engine without superheater, and 30·6 per cent. better than the compound engine.

Experiments have recently been carried out on a passenger steamer running between Europe and America. The official results have not yet been published, but the advantage of superheated steam has shown itself to be indisputable, and to amount to about 15 to 20 per cent. saving in coal consumption.

A very interesting feature connected with the use of superheated steam is that the higher the superheat the less is the economy to be obtained by using high pressures. At 663 degs. Fahr. superheat, for example, the difference in consumption between 130 lbs. and 170 pressure is only 1 per cent. in steam and 2 per cent. in coal.

Its Economy

The economy of superheated steam may perhaps be best realised by comparison of the steam consumption of various types of engine with saturated and highly superheated steam. Thus : 24 lbs. of steam per i.h.p. hour may be taken as a good average for single cylinder engines with steam jacketed cylinder running non-condensing. The use of highly superheated steam (that is, steam at a temperature of about 600 degs.) leads to a reduction in the steam consumption per i.h.p. hour in an engine of this type to about 17 lbs.

A similar comparison between single cylinder condensing engine running with saturated and highly superheated steam yields an equally marked result. The figures obtained as the result of several trials are as follow: Single cylinder condensing engines with saturated steam require 22 lbs. per i.h.p hour, but with highly superheated steam only about 14 lbs.

Results of tests on compound non-condensing and compound condensing, with and without superheat, show similar results, but not in so marked a degree. The steam saving in the case of the compound non-condensing is 28 per cent. when working with superheated steam as compared with saturated steam, and in the case of the compound condensing the relative economy is 31 per cent. To put the matter plainly, the use of highly superheated steam places a single cylinder non-condensing engine on a par with a single cylinder condensing engine using saturated steam, and enables the compound non-condensing to give similar results to those obtained when working condensing.

And Efficiency.

It is now a number of years since superheated steam was first practically used, and at the time some difficulty was found in obtaining suitable oils for lubrication. This, however, has been entirely overcome, and since the subject has received the attention it deserves at the hands of competent and thoughtful engineers, the design of engines to work with superheated steam has been brought to a degree of perfection which entirely does away with any risk of trouble from glands, stuffing boxes, or any other part of the engine. It must not be taken from this that to obtain satisfactory results with highly superheated steam a specially built engine is required. There is no doubt that engines designed to use saturated steam will bear a moderate superheat, which will effect considerable economy, but to obtain the full benefit of superheat it has been found that the steam should be superheated to about 650 or 700 degs. Fahr.

The economy of using highly superheated steam does not end with the saving in steam consumption and consequent saving in coal—a considerable saving in capital outlay is also effected. Smaller boilers are required for a steam plant of a given horse-power, and the economies attendant upon a reduction in number of boilers is by no means inconsiderable. Again, with highly superheated steam, a compound condensing engine may be said to be the most economical type of engine.

Reliable tests on a compound condensing engine using highly superheated steam show that 1 i.h.p. can be obtained with a consumption of under 9 lbs. of steam per hour; this has not been equalled, to the knowledge of the writer, even by a quadruple expansion engine using saturated steam.

New Gold Districts.

Attention has recently been directed to the Thunder Mountain Mining District, Central Idaho, in the United States, and from reports so far issued the district is apparently one of promise, for already some high-grade ore has been discovered; but the principal feature seems to be extensive developments of low-grade auriferous rock, in which, however, the gold is in a free condition, and not associated with base minerals. There promises to be a considerable field for the successful application of simple milling and cyaniding systems. The present centre of activity is known locally as the Dewey Mine, which is situated near the summit of Thunder Mountain, at an elevation of 8,000 ft. There are several drifts and cross-cuts, amounting in aggregate to over 1,000 ft., whilst the greatest depth reached is 200 ft. This is the result of one year's operations; moreover, a ten-stamp mill has been at work since the commencement of January. Thunder Mountain is stated to consist entirely of igneous rocks—in fact, the whole surrounding district for some considerable distance, covering an area of about 4,000 square miles, is said to be of similar character. The particular deposits that have at present been investigated are recognised as consisting of rhyolite porphyry, of brecchia and of tuff, with fine native gold disseminated throughout the mass: their thickness has not yet been determined, but is variously estimated to be from 60 to 600 feet. In the mine itself, specimens containing 10 dwts. to the ton have been obtained, but at present the whole mass is being mined. It averages 7 dwts., and over 90 per cent. of the gold is saved by simple plate amalgamation.

Central Idaho is, of course, not an unknown gold-producing district—in fact, for many years gold has been obtained from its placer camps—but its inaccessibility has discouraged the search for reef mines.

The present locality is far away from rail, and even beyond proper road. It, moreover, as might be expected, is for some period of the year more or less snowed up. But these would prove no obstacles to enterprise if the valuable mineral is there; and gold is not the only valuable commodity spoken of as abundant in this new land of promise.

Another State showing fresh activity in gold production is Arizona. In Juma County the Socorro Gold Mining Company have been opening anew some old workings, and contemplate erecting stamp battery and cyanide works, inasmuch as the ore found averages an ounce of gold to the ton, whilst some bunches of sulphides have shown 5 oz. and 7½ oz. to the ton.

New Copper Field.

There are many well-known copper-producing districts in the world, notably those in the south-west of Spain, in the State of Michigan on Lake Superior, in Butte, Montana, and elsewhere, and recently California is coming to the fore, Shasta County being the scene of this activity, a district remarkable for its varied geological character. In a region where a very irregular belt of igneous rocks, embracing acid and basic lavas, traverses a series of sedimentary rocks, and where there is considerable compression, folding, faulting, and shearing, there are in some of the shear zones irregular bodies of sulphide ore ranging in size from a mere film to masses many hundreds of feet in magnitude; these deposits are the only ones that have been mined successfully. In the Bully Hill district there are a number of such zones, the ore bodies are solid and consist of pyrites, chalcopyrite, chalcocite, occasionally bornite and traces of carbonates and native copper; the general average content is 10 per cent. of copper, but some masses have assayed 15 per cent., while in rare instances as much as 46 per cent. has been reached. The Iron Mountain district is, however, the most important; it is marked by a prominent gossan, which in places extends to a depth of over 100 ft., the change from oxides to sulphides being abrupt. The ore is of almost entirely cupriferous pyrites and chalcopyrite; the content of copper ranges from 1 to 10 per cent., and large quantities have contained 7½ per cent.

Process for Refractory Ores.

For years mining men have sought a process for treating refractory ores without the employment of roasting or calcining operations, and what is known as the Diehl process seems to have achieved this object in Western Australia. It is applied to the treatment of "sands" or finely divided material; which is further pulverised in a Krupp flint mill, consisting of a long cylinder charged with flint balls. This is set revolving, and the ore in form of "sands," charged in at one end, passing out of the other in the form of slimes. These are passed through a 200 mesh sieve and then through classifiers, to separate any uncrushed sand, which is returned to the mill. These slimes, reduced to pulp containing 40 to 50 per cent. of dry material, are agitated in quantities of 100 to 125 tons at a time with very dilute solutions of potassium cyanide for twenty-four hours; additions of cyanide or of cyanogen bromide being made as deemed necessary.

Filter Press in the Mill.

The leaching being complete, the muddy mass is transferred to filter presses, where not only is the solution separated from the solid matter, but the latter is also washed. It is interesting to note the dimensions and capacity of the filter presses. They have a capacity of 4½ to 5 tons. As a rule, they have 50 frames, and the cakes measure 39½ sq. in., are 2½ to 3 in. thick, and weigh when dry 1¾ to 2 cwt. The operations of filling, washing, and draining are effected by means of compressed air, and the treatment of a charge, including the getting ready for a fresh charge, occupies two hours. The gold is obtained from the solutions by passing through zinc boxes much in the ordinary way. The system does not preclude saving as much gold as possible by amalgamation in the ordinary way, in fact the sands are advantageously passed over amalgamated plates before sliming. It would be interesting to hear of the use of the process in other mining districts where there are similar difficulties.

Treating Complex Ores.

There is another process of recent introduction which has done, according to accounts, very well on the famous Broken Hill ore, in which galena and blende are so intimately intermingled as to defy separation by mechanical means. The process is due to Messrs. Sulman and Picard. The crushed ore is subjected to a preliminary roasting in a reverberatory furnace, and is then made into briquettes with 20 per cent. of coking coal, and a small quantity of pitch for a binding agent; the briquetting being conducted in an ordinary plant. The briquettes are submitted to distillation in an ordinary zinc retort furnace, and under the conditions obtaining, the zinc distils off practically without any lead; in fact, the latter metal remains in the coke, and can be obtained by smelting in the usual way.

Regeneration of an Old Mill.

It is rather interesting to note a somewhat similar problem complicated by the presence of magnetic iron ore as well as galena and blende, but in which the latter are not so intimately associated as in the Broken Hill ore, which arises at Pierrefitte, on the French slope of the Pyrenees, and which is being solved in a partially re-modelled antiquated mill. The ore from the mine is passed over a grating, with bars 3 in. apart, and from the larger lumps the pieces of pure galena and blende are picked out by hand, and constitute the only material saved without further treatment. The rest of the ore goes through stone-breakers and screens, then through Cornish rolls and more screens; and of the crushed stuff the coarser portion is treated in jigs, whilst the finer is classified in pointed boxes. The slimes pass over wet magnetic separators to remove the iron ore, and what remains is finally dressed on separating belt tables. In the jigs only one marketable product is made, that is galena in the first compartment. The products of the other compartments either go to the waste heap or are further crushed in another set of rolls and pass through the mill again. So that marketable products are only obtained from the belts and the first compartments of the jigs; all the rest of the equipment is employed in getting rid of waste rock. The main feature and saving factors of the mill are that it is worked by a neat electric power plant and that wet electro magnetic separators and belt tables are in use.

Scandinavian Iron Ore.

When considering available iron ore deposits in Scandinavia, that is, supplies that will be available for the British ironmaster, particular note must be taken of those in the far, far north, for it must be remembered that the output from the Gellivare deposits is almost entirely, if not entirely, appropriated on the Continent. But a railway is in course of construction which will terminate at Victoriahavn on Ofoten Fjord, and will enable ore from the vast deposits north of Gellivare to be shipped to these Islands all the year round. The deposits referred to are those of Kiirunavaara and Luossavaara, situated in latitude 67 deg. 57 min. These are two adjoining ranges of hills separated by a lake, which is about 1,640 ft. above sea-level, and the highest summit of the hills is a little over 800 ft. above the level of the lake. The first of these ranges is 3 miles long and the second about $\frac{4}{5}$ of a mile, and through the whole length of each there is a massive outcrop of iron ore varying in thickness from 100 to over 800 ft. From actual measurements and from numerous bore holes, it is computed that there are 215 million tons of ore in Kiirunavaara and 18 million tons in Luossavaara, or together, 233 million tons of ore above the level of the lake Luossajärvi by name. A goodly store of ore; it is mostly magnetite, but there is some hæmatite; part of it, too, is pure and of high quality, but the rest, the greater part probably, is mixed with apatite, but, of course, there are, or will be, means of separating these in a satisfactory manner.

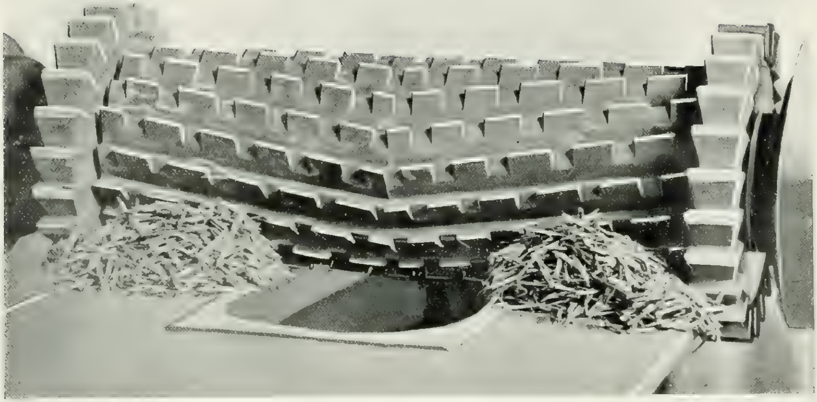

FIG. 5. MILLING A KNEE ON A B. AND S. MACHINE.

MILLING MACHINES.[*]

BY

JOSEPH HORNER.

Treats of the General Design of the Pillar and Knee Types, both Plain and Universal.

II.

THE PILLAR, FOOT, HEADSTOCK, OVERHANGING ARM, KNEE.

THE horizontal spindle machines of the pillar and knee type, and modifications of the same, will form the subject-matter of the present article; some of their fittings and adjuncts that of the article to follow. The general designs of these and variations therefrom are illustrated by the photographs. The broad features by which they are characterised are shown in the vertical section through the centre of a machine (fig. 1).

The pillar or column A is of the boxed form, and is utilised as a cupboard for tools. Its sectional plan is rectangular, with well rounded edges. The base is broad enough when bolted down to sustain the entire machine steadily. During the last two or three years the earlier plain foot with rounded edges has been giving place to the waste oil tray foot B, which has the edges turned up all round, so keeping the floor free from drippings of oil. The headstock C is usually cast in one with the pillar, and lugs are provided for carrying back gears in all machines except the smallest. The upper portion of the headstock is often formed as a long boss D, as shown, to receive the overhanging arm E, instead of having two separate bosses, and it then serves the purpose of rigidly connecting the uprights of the head, together with the spindle bearings. The boss D has split lugs at each end for the purpose of clamping the arm in any position required. In the Brown and Sharpe machine, shown in fig. 3 (from photograph supplied by their agents, Messrs. Buck and Hickman), a new

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[*] In the first paper the various classes of Lincoln type machines were discussed and analysed.—Ed.

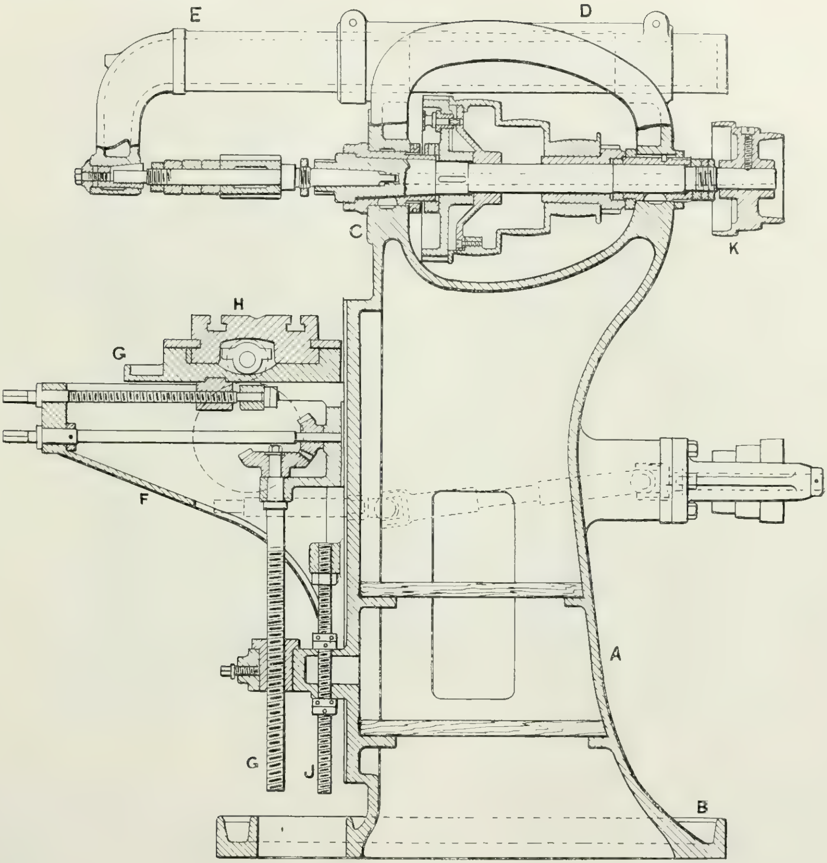


FIG. 1. MILLING MACHINES II.

clamping arrangement is introduced. A lever seen in front operates a shaft with rack teeth that engages with the nuts on the clamping bolts, so pinching both ends of the arm by one movement of the lever.

The overhanging arm E (fig. 1) is either formed with a turned-down end as illustrated, to receive a bushing that supports one end of the arbor, or it is a plain bar (figs. 2, 3, 4, and others) to take a sliding bracket which fulfils the same function. The turned-down end, or the bracket, can be thrown out of the way when not in use, which happens when face mills, or some of the special milling attachments are put on. An advantage of the straight arm is that any of the regular adjuncts of the machine can be attached without the necessity of removing it or turning it aside, which must often be done with the bent arm.

The knee F slides on broad faces on the front of the pillar. It is elevated and lowered by means of a square thread screw G, passing down

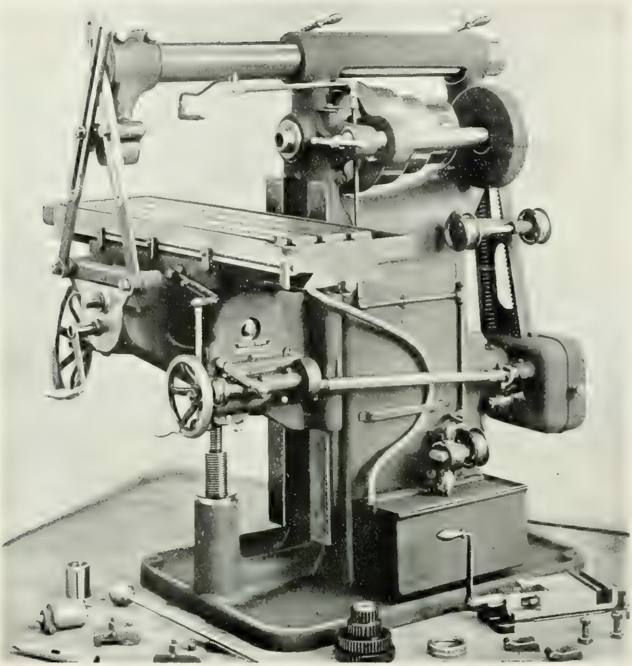


FIG. 2. PLAIN MILLING MACHINE, BY THE BROWN AND SHARPE MANUFACTURING CO., PROVIDENCE, R.I., U.S.A.

through a deep boss cast with the foot. In most machines the descent of the table into its lower positions involves cutting a hole through the floor to allow the screw to pass down. This is objectionable in many cases, as when it has to go through concrete, or when it affects insurance rates. A telescopic arrangement of screw and bush, as used by Wm. Muir, the Cincinnati Company, and Brown and Sharpe, avoids this inconvenience. This arrangement is seen in the Brown and Sharpe machines (figs. 2 and 3, and in the Hendey machine (fig. 11). Except in the largest machines, the knee is generally elevated and lowered by hand, but in the heavier ones power is properly fitted. Provision is made for clamping it at any height by means of hand levers, which are seen best in the photograph of the Hendey machine (fig. 11), without the trouble of using spanners, a device wherein most new machines compare favourably with the older ones.

The knee, with the load which it carries, is always a weak point in poorly designed machines, due to its excessive overhang and instability. A mean has to be struck between a large table having considerable amounts of traverse, which in themselves are desirable, and a smaller table and shorter traverse. The limits of rigidity are soon reached, beyond which increased dimensions and ranges must be obtained in other types of machines. From this aspect the Lincoln miller has the advantage over the pillar and knee, while on the other hand the latter has an open side, more convenient for the handling of large pieces, and control by the operator.

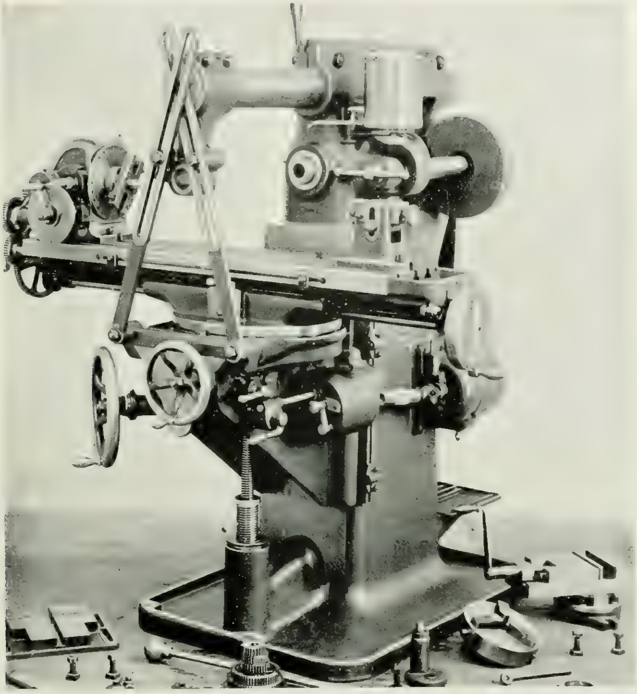


FIG. 3. UNIVERSAL MILLING MACHINE, BY THE BROWN AND SHARPE MANUFACTURING CO., R.I., U.S.A.

But we have seen Lincoln types converted into open side machines, and some of these illustrations show the knee types fitted with auxiliary supports and bracings.

THE DIFFERENCE BETWEEN PLAIN AND UNIVERSAL MACHINES, THE TABLES AND THEIR MOVEMENTS, TOOL MAKING AND MANUFACTURING MACHINES.

The above description, so far as it goes, applies to both plain and universal machines; but the fitting of a swivel table to the latter makes a difference in the construction above the knee. Fig. 1 is a plain machine, and in it the saddle G, which fits and slides across the knee, receives and coerces the plain table H by gibbed edges. But in the universal (see figs. 3 and others) the saddle receives a swivel carriage fitting by a large central pin, and tightening bolts for fixing at any angle to 45 deg. in some cases, or through a complete circle in others. This saddle receives the table by vee slides.

Tables have oil channels at the sides draining into pans at the ends, and the latter have plugs or taps for draining off the oil. Tables have automatic feed in each direction, the drive being central, and its direction is changed by a lever in front of the table, which can be tripped by dogs. The feed can be released by an auxiliary lever which operates at any angle at which the table may be set. The precise amounts of each movement of the table are indicated on adjustable dials which are graduated to read to thousandths of an inch. The

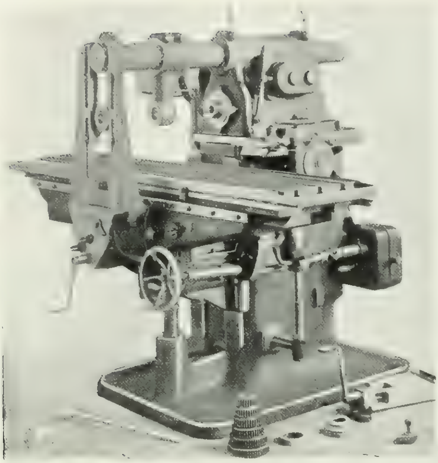


FIG. 4. PLAIN MILLING MACHINE, BY THE BROWN AND SHARPE MANUFACTURING CO., R.I., U.S.A.

degrees of angle to which the table are set are also read off. A screwed stop rod J (in fig. 1), with adjustable collars, is used to adjust and set the height of the knee.

Though the essential difference between a plain and a universal machine is that the table of the first-named does not swivel, while that of the second does, yet there are other differences usually made. Thus, the universal head and some other attachments, though properly belonging to the universals, may be, and often are, adjuncts to the plain machines, so that dividing, and spur, and bevel gear cutting can be performed on the latter. But spiral gears are the exception which cannot be produced on these, because the table cannot be swivelled for angle. And beyond the fact that many attachments are common to both, plain machines are generally of stiffer build, and with the same object they are usually fitted with bracing to sustain the end of the overhanging arm under heavy cutting.

Generally, the tables of plain machines are operated by a rack, those of universals by a screw, though this is not invariably the case, and makers will supply either drive to the plain machines. The advantages of the screw feed are finer precision in operating, and the fact that it is practically locked immediately the feed is disengaged. Using a rack, the position of the table can be altered by hand more rapidly, which facilitates setting and removal of work.

The early universals were tool-making machines, and though exceedingly useful, were of light build. The first was patented by J. R. Brown in 1865, and was exhibited by Brown and Sharpe at Paris in 1867. This, the original type, has been retained through many improved and stiffened forms. Now these are classed either as tool-making, or as manufacturing machines, and the latter term is also applied to plain millers. The first are intended primarily for use in the tool room, the second for heavy and general manufacturing processes. The first are light, the second massive, but the latter have been developed from the first.

DETAILS OF MACHINES, DIMENSIONS, HEADSTOCK DETAILS, FEEDS, OVERHANGING ARM, BRACING.

From this general account we next observe some of the leading details of these machines.

Milling machines are generally classed by their makers by numbers, which is a convenient designation as indicating those of certain dimensions. In plain and universal machines these dimensions are, the length of the two movements of the table—longitudinal and transverse, which governs respectively the length and width that can be tooled; the distance from the end of the spindle to the centre in the overhanging arm, which controls the length of arbor and cutters that can be utilised; the distance from the centre of the spindle to the overhanging arm, by which the diameter of the cutter is limited, the depth to which the table is capable of adjustment, and the size of the table.

In one respect these milling machines resemble the lathe—namely, in the headstock details and in the feeds. The spindle is run by belt direct, or through back gears, while the feeds are through belt, or are positive through toothed gears. But in these two matters there are broad differences in machines by different manufacturers. The front necks of the spindles are coned, a hole runs right through them, as in hollow spindle lathes, and the nose is threaded. The bearing necks of the spindles are also in present day practice made very large in order to

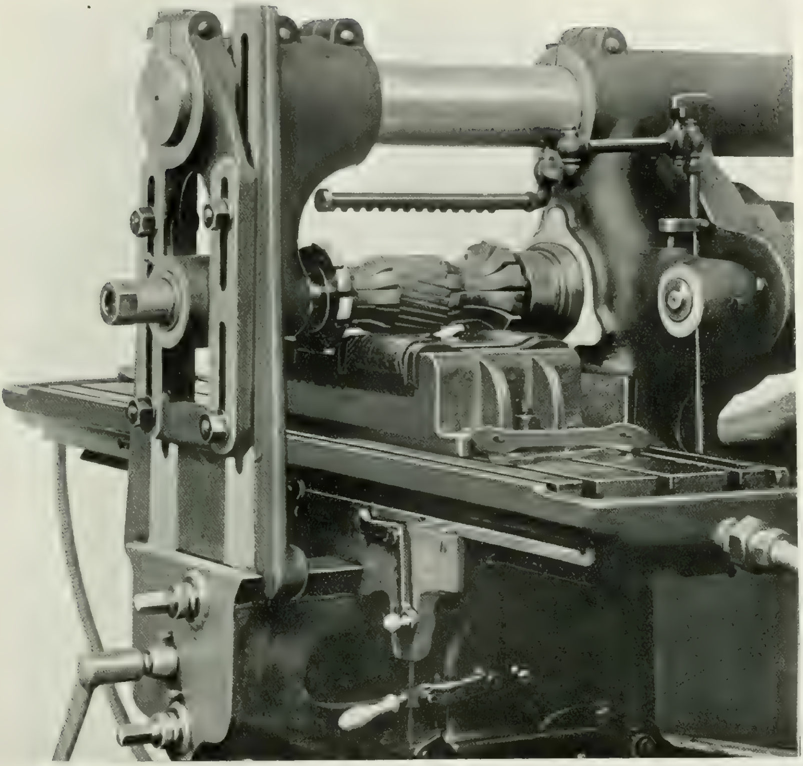


FIG. 6. PLAIN MILLING MACHINE, WITH GANG OF CUTTERS, MILLING A NUMBER OF CONVEYOR LINKS FROM THE SOLID. A. HERBERT, LTD., COVENTRY.

delay wear as long as possible. Every precaution that experience can suggest is embodied in modern machines to take up wear, and to prevent access of dust to the spindle necks. The bearing box is either of bronze or phosphor bronze, or of cast-iron lined with compressed Babbitt metal, and it is adjusted over the neck by means of a lock nut. The adjustment of the hinder box, the bearing and neck in which is parallel, is similarly accomplished. A dust cap is fitted over the front of the front bearing, and the thread of the nose is protected, when not in use, by a cap screwed over it. The spindle nose is bored with a standard taper hole, usually B. and S.

A universal chuck generally forms a portion of the equipment of the machine, and it is interchangeable on the indexing and dividing head. The chuck is valuable for cutting off stock which is passed through the hollow spindle, for holding drills, and reamers, and special milling cutters.

There are two, and in the heavy machines three, automatic feeds, also hand operated; the longitudinal or traverse, the cross or transverse, and the vertical. The number of changes in feed

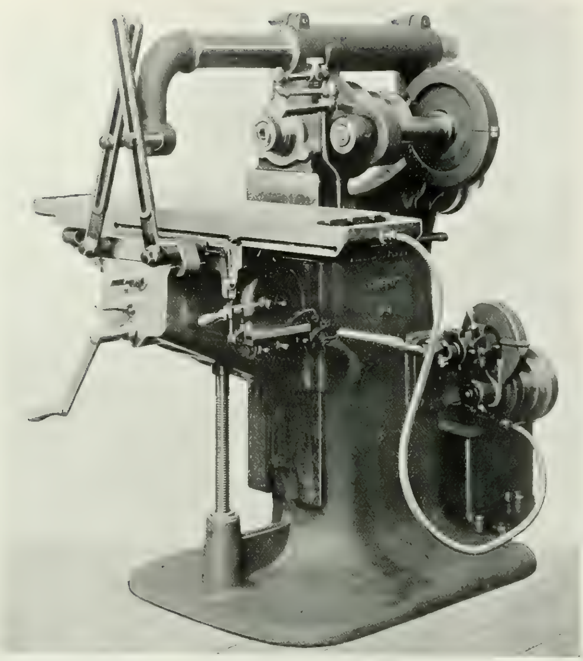


FIG. 7. PLAIN MILLING MACHINE, BY ALFRED HERBERT, LTD., COVENTRY.

usually ranges from eight in the smaller to twelve or sixteen in the larger machines, and they are given in fractions of an inch per revolution of the main spindle, when, as in all the older machines, and in many as now made, the feeds are derived directly from the spindle. The first or driving set of stepped feed cones are in this design put on the rear of the spindle, as in fig. 1, K. But in a considerable number of machines of recent design the feeds are independent of the spindle speeds. The total range of feeds in the first named design is obtained by transposing the feed-cone pulleys when the changes of the belt on the steps for one position of the pulleys are exhausted. The lower pulleys then have their bearing in an adjustable bracket which permits of tightening the belt. A telescopic shaft coming from the lower pulley adjusts itself to the varying height of the knee, and is connected at the latter to the axis of a worm which drives a wheel, from the spindle of which the longitudinal and cross-feeds are derived in various arrangements of gears and shafts.

In the latest Brown and Sharpe machines, which are illustrated by figs. 2 and 3, a new variable feed motion is embodied, which is driven from the main spindle by a chain and sprocket wheels, spur gears being used in the feed box at the rear, producing the changes. Spur gears are also used in the knee. The telescopic shaft seen to the right transmits the changes to the gear-case at the side of the knee—the feed reversing and starting and stopping mechanism in which is operated by a lever. The levers seen in front of this operate the vertical and transverse feeds by power. A safety screw is placed in the telescopic shaft to

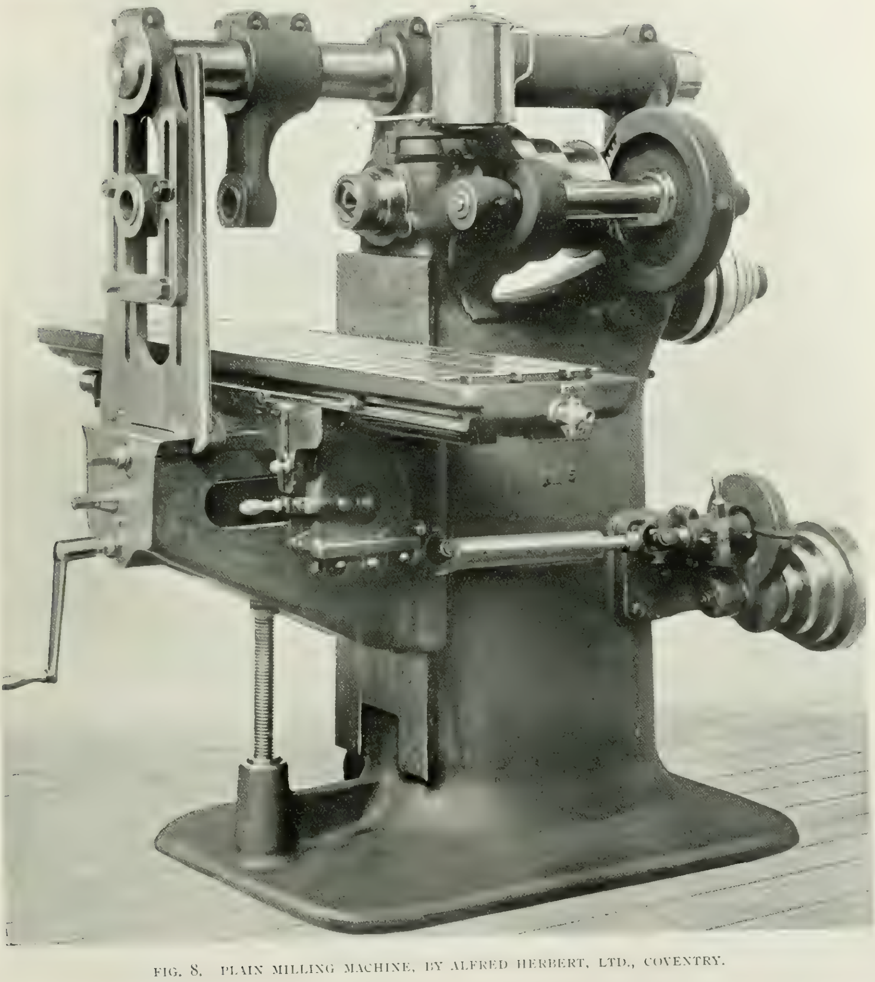


FIG. 8. PLAIN MILLING MACHINE, BY ALFRED HERBERT, LTD., COVENTRY.

break under any undue strain, and so prevent possibility of the positive feed from causing injury to the cutters or to the machine.

Making the feeds of the table independent of the speeds of the spindle is an innovation of recent years, and not universally applied at the present time. But this is considered by many as one of the most valuable improvements yet effected. When feeds are derived from the main spindle instead of from a separate pulley on the countershaft the result is that the high speeding of the

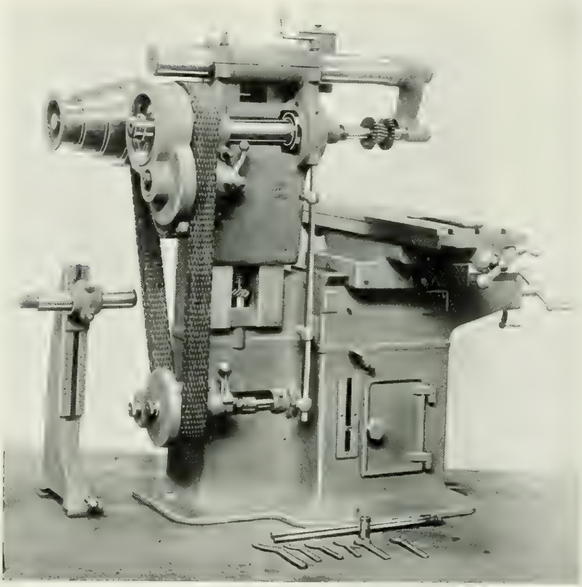


FIG. 9. PLAIN MILLING MACHINE, BY THE RICHARDS MACHINE TOOL CO., LONDON.

spindle for small cutters gives too rapid a feed to the table, while with the slow speed necessary for large cutters the table is fed too slowly, especially for finishing cuts. The independent feed does away with these drawbacks. The theoretical objection that in the event of the main spindle failing to operate while the table continues to feed up to the cutter, with consequent disaster, is apparently not borne out in fact.

Messrs. Alfred Herbert, Ltd., of Coventry, have combined both methods of feeding in their new machines, shown in fig. 7, and classed as their No. 4, and in fig. 8, classed as their No. 5. The feed can be driven either from the spindle or the countershaft. In the first case there are twelve changes, ranging from ·005 in. to ·09 in. per revolution of the spindle; in the second there are sixteen changes, from ·001 in. to ·20 in. per revolution. In fig. 7 the range of feed when driven from the countershaft gives twenty-four changes, from ·37 in. to 6·54 in. per minute; in fig. 8 thirty-two changes, from ·5 in. to 12·75 in. per minute.

In the first-named drive the upper feed cone is not placed on the spindle, but is geared to it and runs at twice the spindle speed, giving twice as much power as when the cone goes on an extension of the spindle. The cones can be transposed, and for any one arrangement of them another rate of two to one is obtainable by the movement of a handle, seen in the illustration, without stopping the machine or changing the feed belt. This is of value when changing from a roughing to a finishing cut, and *vice versâ*. An automatic stop is provided to the feed, and also a dead stop.

The fitting of the overhanging arm follows two main designs. In one it is bent downwards to form the bearing for the outer end of the arbor; in the other it is parallel, and carries a sliding bracket, the lower boss of which receives the end of the arbor. Either the arm in the first case or the bracket in the second is clamped

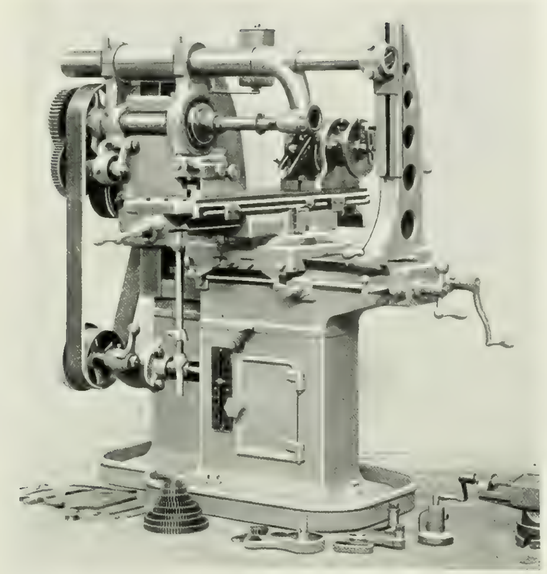


FIG. 10. UNIVERSAL MILLING MACHINE, BY THE RICHARDS MACHINE TOOL CO., LONDON.

in divided bosses on the top stay of the head of the machine. The free end of the arbor is secured in the boss of the overhanging arm. In some machines the end of the arbor revolves by a cylindrical fitting, hardened and ground in a bush of phosphor bronze in the arm. Provision is made for taking up wear by closing the bushing concentrically, and three key ways are milled in it so that it can be turned one-third round in its seating to equalise wear. In others the arbor is supported by a point centre. The advantage of supporting the arbor by a cylindrical fitting in a bushing instead of on a point centre is that it permits the arbor to expand lengthwise as it becomes warmed by the work of the cutters.

As the stress of heavy cutting is often so severe that it could not be borne by the overhanging arm alone, without chatter, nearly all plain and many universal machines have bracings fitted to connect the end of the arm to the knee. There is a vast difference between cutting flutes in taps or reamers, or the teeth in small wheels, or tooling narrow surfaces generally, and performing the tasks shown in figs. 5 or 6, which is work that is now expected as a matter of course on pillar and knee machines, and which explains why outer bracing is so often fitted to these, to be used or not as is found necessary.

The bracings used to tie the arm and knee together are either cross or parallel. Sometimes two separate bracings are pivotted in bosses at the outer end of the knee, and are clamped where they cross by one bolt passing into the bend of the overhanging arm. Long slots in the bracings permit of their adjustment over the bolt at the varying heights of the table; but in most instances each brace has its own locking bolt. Examples of this kind are seen in figs. 2, 3, and 7.

In some of the parallel bracings a casting fits over the top faces and edges of the knee, and has two slotted parallel ways above to receive

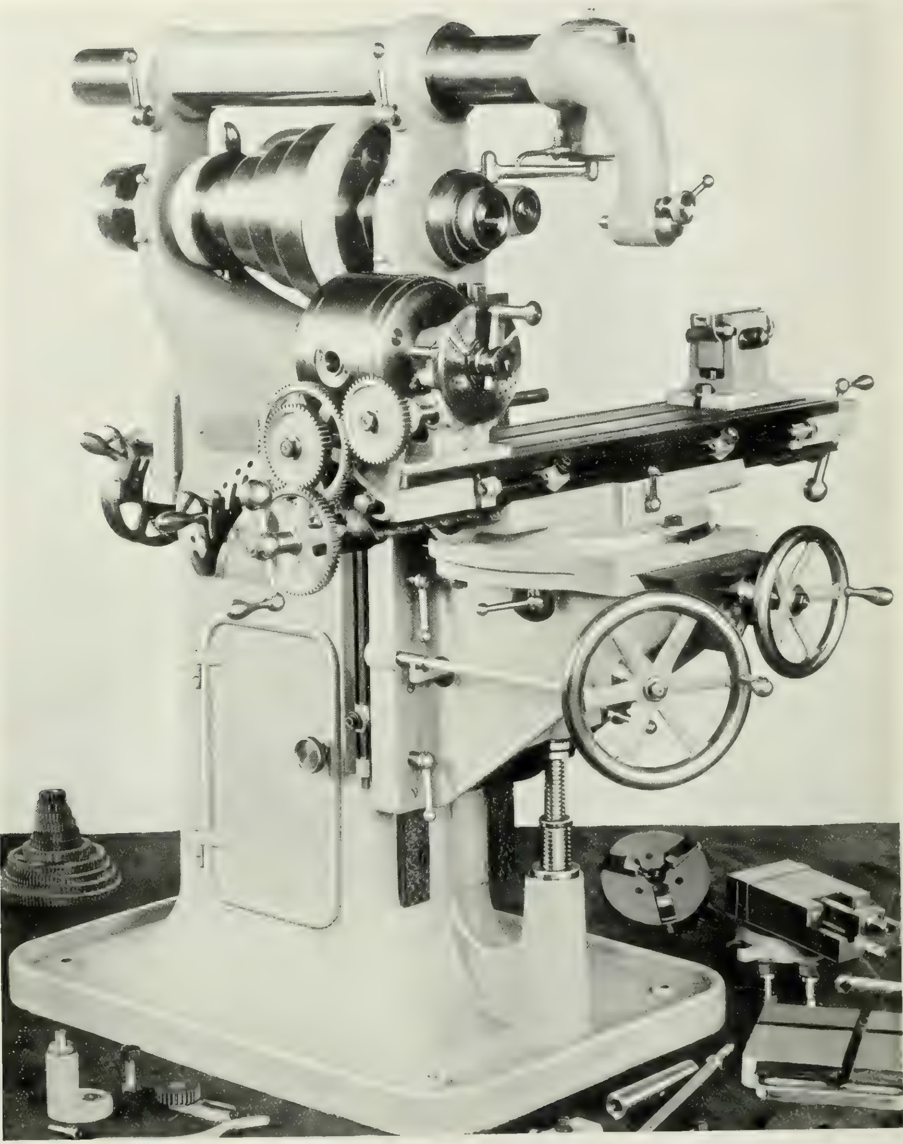


FIG. 11. UNIVERSAL MILLING MACHINE, BY THE HENDEY MACHINE CO., TORRINGTON, CONN., U.S.A.

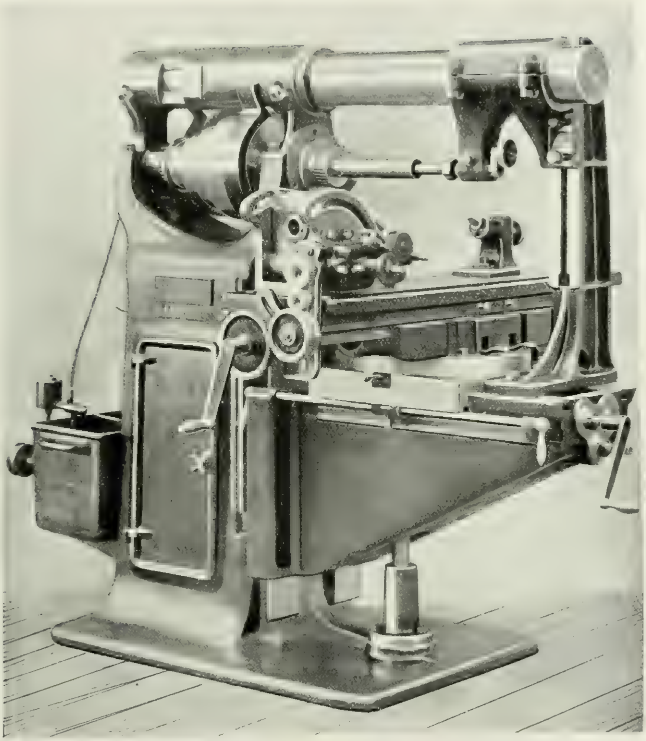


FIG. 12. UNIVERSAL MILLING MACHINE, WITH DIVIDING HEAD.

the clamping bolts that pass into bosses in the overhanging arm. In another type two slotted castings with parallel arms are used, one sliding on the other. The lower one is attached to the knee, the upper one to the overhanging arm, and slot holes corresponding in each permit of their vertical adjustment one over the other. Examples of this kind are seen in figs. 6 and 8.

In one type of solid brace, a split boss at the head of the brace fits round the overhanging arm, which is of the parallel class. The lower part of the brace is forked, and has slots to embrace two bolts on the knee. A bored boss on the upper portion of the brace receives the centre for the arbor.

IMPROVEMENTS IN RECENT MACHINES, OPERATING HANDLES, CLUTCH FITTINGS, COVERING IN OF GEARS, LUBRICATION.

A detail in which recent machines are superior to the older ones is in the position of the operating handles. In the best designs these are so arranged as to be within immediate reach of the attendant, being located nearly at one spot, and without sticking out awkwardly, yet without interference. Thus the spindle by which the knee is adjusted vertically is set at an angle coming out at one side of and close to the spindle for the transverse feed. Figs. 2 and 3 illustrate this feature. Adjustments can thus be readily effected simultaneously. Another improvement on the older forms is the clutch fittings by which handles may be instantly engaged, or disconnected, without affecting adjustments. Another is in the use of ball bearings to the elevating screw, and sometimes to the table feed screw. Another point to be observed is that the machines of the last two or three years have their gears enclosed by neat protecting guards, with well rounded edges, as seen in the photos. Another feature is the oil pump, tank, pipes and spreader now applied to numerous machines. These arrangements are best observed in the photos, figs. 6 and 7. These, with some other improvements now applied generally to high class tools, render the plain and universal millers much superior to those of ten or even five years ago. The foregoing description applies to standard forms of the machines of the pillar and knee type. The remainder of this paper will deal with variations in the general design.

THE RICHARDS ANGLO-AMERICAN MACHINE.

This is a new design illustrated in figs. 9 and 10, which even in these days of novel departures arrests the attention. With regard to its special functions and applications in practice, it is intended to fill the place of the universal and plain machines of the pillar and knee type. Its knee, however, is not movable, but is in one with the pillar, and therefore adjustment for height is given to the spindle in a fashion which, in combination with the tail support, bears close resemblances to the Lincoln miller. But the tail of the arbor is supported by an overhanging arm as in the pillar and knee machines, and the tail support merely steadies the arm. Though the separate details of the machine are therefore not novel, the general arrangement is.

We have previously remarked on the weakness incidental to the employment of the knee and the overhanging arm. Though a bracing affords a great help in such a design it would often be better if it could be abolished, because it blocks the way to wide work, while from a mechanical point of view members should be sufficiently rigid in themselves. An explanation of this anomaly is that the present-day machines are built after the designs of more than forty years ago, when its only duty was that of milling very light articles, while at present heavy manufacturing work is commonly done on it. A similar conservatism in practice is evident in other machine tools.

One of the weak features of the knee is due to the fact that its overhang prevents giving that amount of movement to the table in a direction to and from the pillar which is often required. If a table is supported on a solid fixed base there is no limit to the size of table and traverse which can be adopted, and it is also possible to swivel a table completely round instead of within a limited number of degrees of angle.

As the vertical movement is imparted to the spindle head in this machine, provision has to be made for a variable length of belt for driving the spindle, with a tightening arrangement. As the centres are short, a link belt is employed, as being more flexible than solid leather and requiring less tension. It drives from the fixed stepped cone through idlers and a tightener.

The details of the spindle are generally similar to those of many other machines. It is hollow, the back and front bearings are parallel, in phosphor bronze bushes. The front bearing is encircled by a conical bush, which is adjustable lengthwise with nuts. End thrust is taken by a thrust bearing of rollers and steel collars. The nose is bored with a standard taper B. and S. hole, and is threaded externally. Bolts are used to pull the arbors in and to push them out, and a nut on the arbor forces them out. Back gear is fitted at the rear end. The driving pulley of the spindle does not take a bearing on the spindle itself, but on a bearing which projects from the saddle that carries the spindle, so avoiding strain on the spindle due to the tension of the belt. This is a device, by the way, which has answered well in drilling machines and automatic screw machines. The end of the overhanging arm has a phosphor bronze bush to support the end of the arbor by the outside in preference to a point centre. The supporting bracket is removable when light milling on large pieces is done.

The feed on these machines, which ranges from 1-5th to 1-800th of an inch, is different in some respects from other makes. It is not positive—that is, it is not driven from toothed wheels, but from a belt which is primarily operated from the idler pulley in the base of the standard. The principle resembles that of the Evans friction cone. The result is that although certain precise rates of feed are indexed, yet they can be changed gradually through all intermediate rates, and while the machine is in operation, as in the friction disc and roller, common on many machines. The points in favour of a feed of this character are these : A belt feed if sufficiently powerful will perform its work under heavy duty as well as a positive feed by gears or chains, yet it will not cause any fracture, but will slip, should a hitch occur. It is desirable to be able to change the feed even while a cut is in progress, as in some cases where the depth of cut varies, or differences occur in the hardness of the metal. A large range of feeds obtainable while the machine is running is desirable in order to secure the maximum results in the duty of a machine.

The base of the machine under the column is utilised as a reservoir for oil or water, and a pump is attached to the back of it. A floor pan to catch waste lubricant is fitted separately.

THE BEAMAN AND SMITH MACHINE.

Beaman and Smith, of Providence, R.I., make a pillar and knee machine of massive and rather special design for heavy work. The spindle head has a range of horizontal adjustment on top of the pillar of 3 in., the knee with its table has the usual movements, vertical, longitudinal and transverse. The table measures 6 ft. long, by 14 in. wide, and its feed, of twenty changes, is equal to its full length. The front spindle bearing is 6½ in. diameter, and the overhanging arm measures 8 in. diameter. The weight of the machine exceeds 3½ tons. In a very special machine of the pillar and knee type by this firm the table has a vertical face with tee slots, and a return piece below to carry and support deep heavy work.

THE HENDEY MACHINE.

A new American machine by the Hendey Machine Company, of Torrington, Conn., is illustrated in fig. 11. It embodies the best points in recent practice already mentioned, but its special interest lies in the application of the Norton system of mounted gearing which has been employed on lathes during several years past. Six changes in the gear box, seen to the left hand of the pillar, with three settings of the sliding gears at the back of the machine, give a total range of eighteen rates of feed.

REINECKER MACHINES.

Though German machines are largely built after the American models, yet there is a great deal of original and special design besides. The following may be noted :—

J. E. Reinecker, of Chemnitz-Gablenz, represented in England by Pfeil and Co., Clerkenwell, has embodied the best points of the present-day practice in his standard machines. Besides this, some highly specialised tools are also modelled after the general type of the pillar and knee and others.

In the universal machines the circular slide on the saddle can be turned through a complete circle without interfering with the feed motion. The front bearing of the spindle is conical, and provision for taking up wear is embodied both in the front and back bearings. End thrust is taken by friction washers hardened and ground. The spindles are hollow. The straight type of overhanging arm is used, and the outer bearing for the arbor is fitted either with a point centre, or a longitudinal tapered bush to support the outer end of the arbor. A bracket standing up from the knee and sliding thereon forms an efficient brace, and is removable at will. The arbor support is fitted with an extension on which the vertical face of the bracket slides, and to which it is bolted. In another machine the outer support bridges the face and edges of the knee and has two uprights with slots, over which slides a clamping piece with arms at the end of the horizontal arm.

Messrs. Reinecker recommend generally the selection of a machine of universal type, even though plain milling only is wanted, because since the table swivels, the machine can always be converted into a universal by the addition of the dividing and spiral heads. Several of these machines are fitted for electric driving, the motor being on the base, or at the side of the pillar, just above the base.

The usual attachments common to this class of machines are fitted, including vertical spindles.

These and other arrangements of German and French machines would afford scope for much interesting study, but the dividing and spiral heads, and numerous adjuncts of the pillar and knee machines, have yet to be considered in another article.

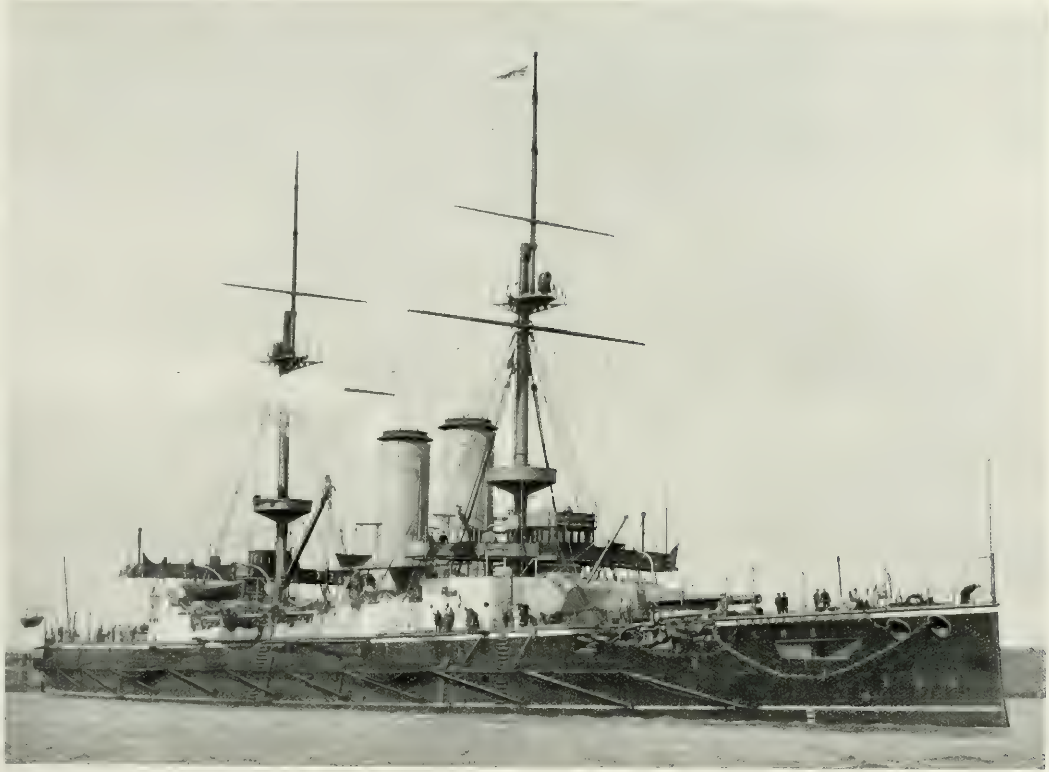
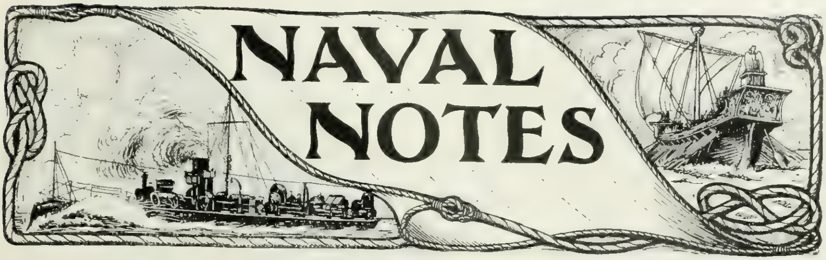


Photo by Johnson and Logan, Portsmouth]

THE BRITISH BATTLESHIP "RUSSELL."

Laid down, March 11th, 1899. Launched, February 19th, 1901. Displacement, 14,000 tons. Heaviest Gun, 12 in. Thickest Armour, 7 in. I.H.P., 18 000.
Nominal Speed, 19 knots.



NAVAL NOTES

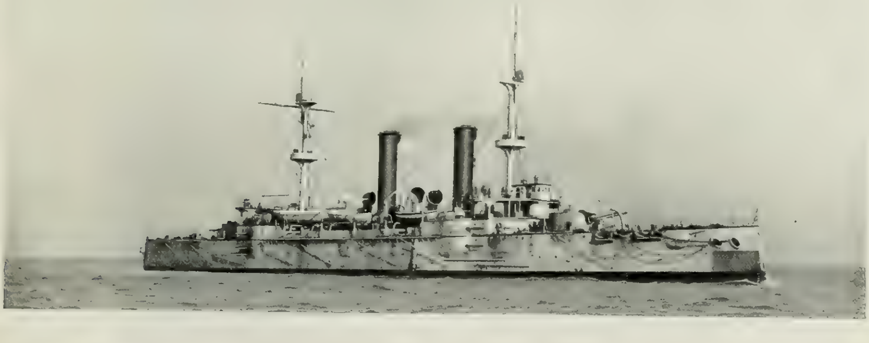
MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT.

BY

N. I. D.

WRITING while the last ship sent by a foreign Power to honour King Edward VII. is yet in our waters it is natural that, in these notes, something should be said about the strangers we have recently had at Spithead. Every student of naval affairs, that could do so, will have visited these vessels, taken stock of them, and, as it were, weighed them in the balance with similar ships of his own country. Regarded in one aspect it is doubtful if the Briton could be altogether satisfied, for it is indisputable that for their tonnage the fastest ships and those most heavily armed flew foreign flags. From another point of view, however, there is consolation, for these vessels which win our admiration bear the impress of the English designer and shipwright. The question therefore suggested is to this effect—why, if a British naval architect can design and a British shipbuilder can construct such vessels for foreigners, does not the one and the other design and produce as good ships for their own country?

The reply to this question, if not the answer to it, has a twofold character: the foreign ships may not actually be better than the British



THE JAPANESE ARMOURED CRUISER "ASAMA."

Built at Elswick. Displacement, 9,750 tons. Heaviest Gun, 8 in. Thickest Armour, 7 in. I.H.P., 13,000. Nominal Speed 20.87 knots.
Built by Armstrong, Whitworth and Co., Ltd., Newcastle-on-Tyne.

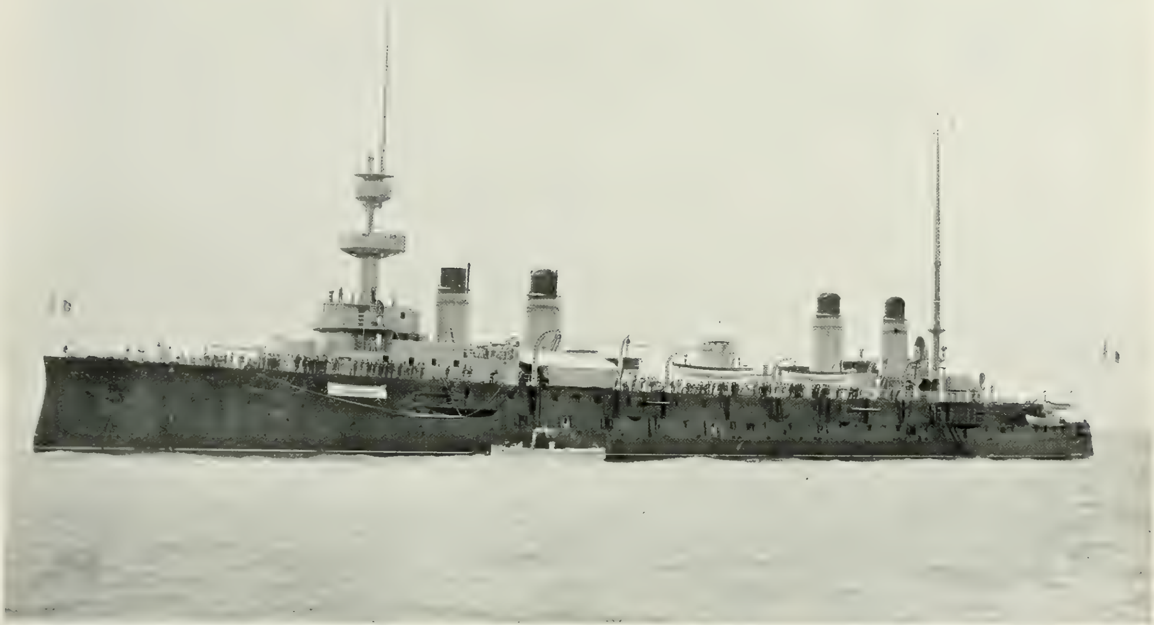


Photo by Gregory and Co., Ltd., Strand.]

THE FRENCH CRUISER "MONTCALM."

Laid down, 1898. Launched, March 28th, 1900. Displacement, 9,516 tons. Heaviest Gun, 7.6. Thickest Armour, 6 in. I.H.P., 19,600. Nominal Speed, 21 knots ships for a British purpose; or, on the other hand, it may be that the regulations laid down by the Admiralty in regard to work contracted for by private firms are of such a nature as to prevent the Government from getting the very best results. These two aspects of a most important matter afford subject for considerable discussion—discussion which is somewhat foreign to the purpose of these notes. Among the readers of this Magazine there must be, however, many who can help in the elucidation of the problems presented, and they certainly deserve, nay demand, the earnest attention of all who are interested in the future of our shipbuilding industry and the efficiency of the Navy of the realm.

Before dismissing this subject and turning to our more immediate object, it may be pointed out how the foreign ships at Spithead bear out, in a remarkable degree, the statement made in these notes last month, that warship design shows in each class a gradual approximation to one type. While there are differences in regard to the amount of gun power, or the import of speed, there is still a great similarity in the plan of the three battleships which foreigners sent to Spithead. In the coast-defence vessels the same feature is apparent, and in the cruisers it is even more remarkable. We need not labour the point here, but it is one which merits more than a passing consideration both on the part of the naval officer and the naval architect.

GREAT BRITAIN.

The departure of the *London* for the Mediterranean leaves the *Venerable* the only battleship of the programme of 1898-99 unfinished. This vessel, which was laid down at Chatham on January 2nd, 1899, and launched in November of the same year, made her steam trials last May. The eight hours full power run gave the following results: Draught of water, forward 26 ft. 4 in., aft 27 ft. 1 in.; speed of ship, 18·3 knots; steam pressure in boilers, 294 lbs. per square inch; air pressure in stokeholds, 0·1 in.; vacuum in condensers, starboard 26·8 in., port 27 in.; revolutions, starboard 101·1, port 102·4; mean i.h.p., starboard 7,600, port 7,745—total, 15,345. The coal consumption worked out at 2·14 lbs. per unit of power per hour. These results speak for themselves, and it may be added that this vessel, like her sisters, has Belleville boilers. She should be ready for her gun trials during the autumn, and for commissioning before the end of the financial year 1902-3.

What are known as the *Duncan* class of the programmes of 1898-99-1900, consisting altogether of six ships, the *Duncan*, *Cornwallis*, *Exmouth*, *Russell*, *Montague*, and *Albemarle*, are the next ships to come forward. These vessels, which are 1,000 tons less displacement than the *Formidable* class, are to be the fastest battleships in the Navy. The *Russell* has completed her trials, and on the full power run for eight hours the contract power was exceeded and a speed of 19·3 knots was obtained with 18,229 i.h.p. The *Exmouth* has also passed through a satisfactory test. She completed her trials on June 18th, making on the eight hours full power run a speed of 19·05 knots with 18,346 i.h.p.

As regards armoured cruisers, the *Sutlej* has now joined the *Cressy* and the *Aboukir* under the pennant. Of the remaining three vessels of this class, the *Bacchante* and the *Hogue* have made their trials. The full power run of the *Bacchante* gave a speed of 21·7 knots with 21,520 i.h.p. This result, though satisfactory, was improved upon by the *Hogue*, which, on her eight hours trial, made 22·06 knots with a collective i.h.p. of 21,432. The general characteristics of these vessels may be instructively compared with those of the French *Montcalm* and the Japanese *Asama*, both of which ships have been recently in British waters. Of the four ships of the *Drake* class, three have now completed their trials, with the following results: *Good Hope*, 23·05 knots with 31,071 i.h.p.; *Leviathan*, 23·23 knots with 31,203 i.h.p.; and *Drake*, 23·05 knots with 30,849 i.h.p. The fourth vessel is the *King Alfred*, which has been delivered from Barrow. These cruisers are 500 ft. long, 71 ft. beam, and 26 ft. draught, of about the same dimensions, therefore, as the *Powerful*; they are much better protected, having a 6 in. armour belt 11 ft. 6 in. broad extending for the greater part of the length, but tapering to 4 in. and 2 in. forward, while aft there is a transverse bulkhead, leaving about 100 ft. of the stern of the ship unprotected by side armour, but with an extra thickness of protected deck. The armament consists of two 9·2 in. guns mounted fore and aft in barbettes protected with 6 in. armour and

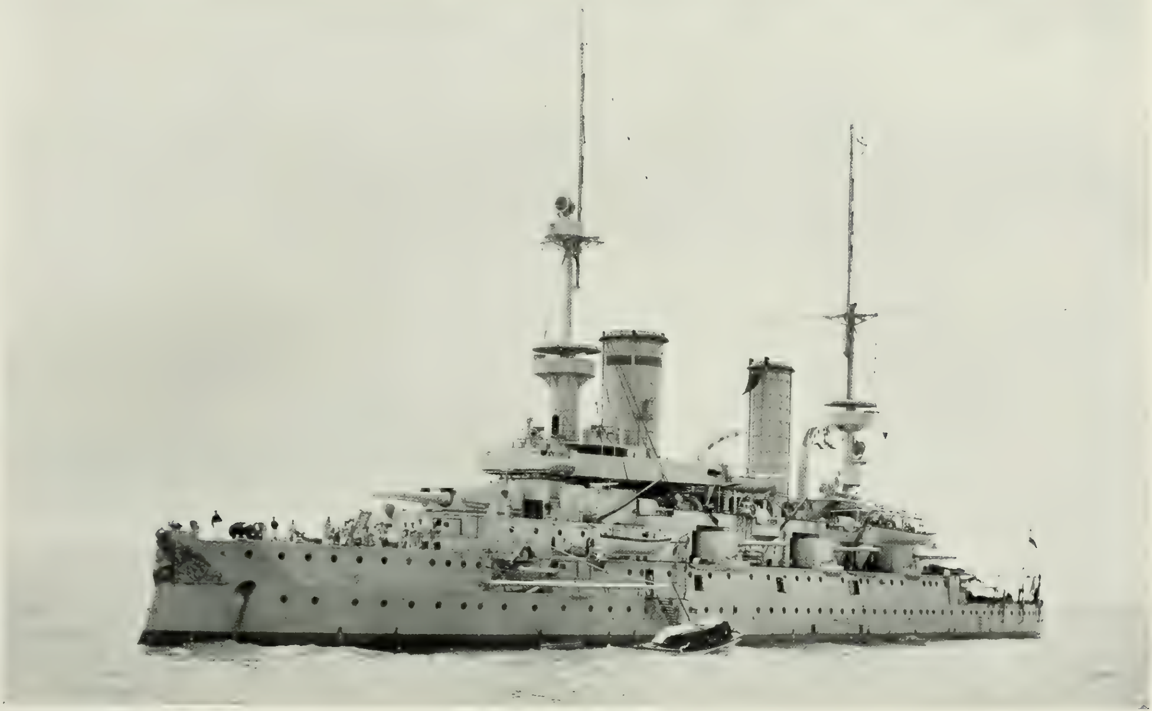


Photo by Gregory and Co, Ltd, Strand]

THE GERMAN BATTLESHIP "KAISER FRIEDRICH III."

Built at Wilhelmshaven Launched in 1896. Displacement, 11,130 tons. Heaviest Gun, 9·4 in Thickest Armour, 12 in I H P, 13 000.
Nominal Speed, 18 knots.

shields; sixteen 6 in. quick-firing guns in two-storied casemates protected by 6 in. armour, and a number of smaller guns.

Of the "County" class of armoured cruisers, the *Bedford*, launched by the Fairfield Company in August of last year, made her trials in June. In her eight hours full power trial, although a collective horse-power of 22,457 was attained, the mean speed was only 22·7 knots, whereas it had been anticipated that 23 knots would be the speed. The result is therefore somewhat disappointing. She is to be tried again with a different set of propellers. The *Cornwall*, of the same class, is to be launched at Pembroke on October 29th. She will be the sixth vessel of this class to take the water.

The two protected cruisers, *Challenger* and *Encounter*, have been launched at Chatham and Devonport respectively, the former on May 27th and the latter on June 18th. These vessels are second-class cruisers of 5,880 tons displacement, 12,500 i.h.p., and 21 knots speed. They are to be armed with eleven 6 in. guns, and are an improvement on their predecessors of the *Arrogant* and *Dido* classes. The *Challenger* is fitted with Babcock and Wilcox boilers, and the *Encounter* with those of Dürr.

FRANCE.

As was mentioned last month, the *Iéna* was the only French battleship to be completed in 1901. The history of this vessel is interesting for purposes of comparison with British ships. She belongs to the programme of 1897. She was laid down on January 15th, 1898, and launched nine months later. She was sufficiently advanced early in the year to make her steam trials, when she easily realised a speed of 18 knots. When, however, she attempted to carry out trials with her heavy guns, some defects developed in the machinery for working the turrets, and this delayed the vessel, so that it was not until April 25th that she could be placed in commission as an effective ship. It will be noticed that from the date of laying down to that of commissioning is fifty-one months. The *Iéna* is, perhaps, the most formidable battleship in the French Navy. She is of 12,052 tons displacement, 15,500 i.h.p., and 18 knots speed. Armour protection is given by a water-line belt of 13·8 in., an upper belt of 4·8 in., bulkheads of 5 in., and decks of 2·8 in. armour. She carries four 12 in. guns in turrets, one pair forward, the other pair aft; eight 6·4 in. quick-firing guns in casemates; eight 3·9 quick-firing guns, and many smaller pieces. She is better protected and more heavily armed than the battleships which preceded her; probably her most vulnerable spot is the base of the second batteries. This ship was illustrated in last month's Magazine, and a reference to the photograph will show how a projectile striking under the casemates might even be assisted in finding entrance by the formation of the sides. The smaller battleship *Henri IV.*, of 8,948 tons, is now undergoing her trials. She was laid down in 1898, and launched in August, 1899. The engines, to develop 12,000 i.h.p., are supplied with steam by Niclausse water-tube boilers, and are expected to give her a speed of 17 knots. She is at Cherbourg. This vessel is also protected by two belts of armour. The water-line belt is complete except for a few feet aft, where an athwart-ship bulkhead forms a continuation of the side armour. The thickness of this belt tapers from 11·8 in. amidships to 7 in. at the ends, and is 7 ft. broad, extending, when the ship is at her normal displacement, from 3 ft. below to 4 ft. above the water line. Above this is the second belt of 4 in. armour, extending from the stem to about 28 ft. abaft the central line of the ship, and above this belt again is a central redoubt protected by 4 in. of steel, in which four of the 5·5 in. quick-firing guns of the secondary armament are mounted. Two other guns of the same calibre are mounted above the redoubt and are protected by shields, and a third is placed in a small turret aft. The heavier armament, consisting of two 10·8 in. guns, is located in two turrets, one forward and one aft, protected by 9·5 in. armour on the face, 12 in. on the base, and 9·5 in. on the supporting tubes which extend downwards to the belt. There are two armoured decks, one 2·2 in. thick and the other 1 in., below this. The vessel has a low free-board aft, but forward is high in order to enable her to steam against a heavy sea.

As regards armoured cruisers, the *Dessaix*, *Duplaix*, *Kleber*, of 7,700 tons displacement—the first-named is under construction at St. Nazaire, the second has been commissioned for her trials, and the third is at Bordeaux, building. The *Dupetit-Thouars*, *Amiral de Gueydon*, and

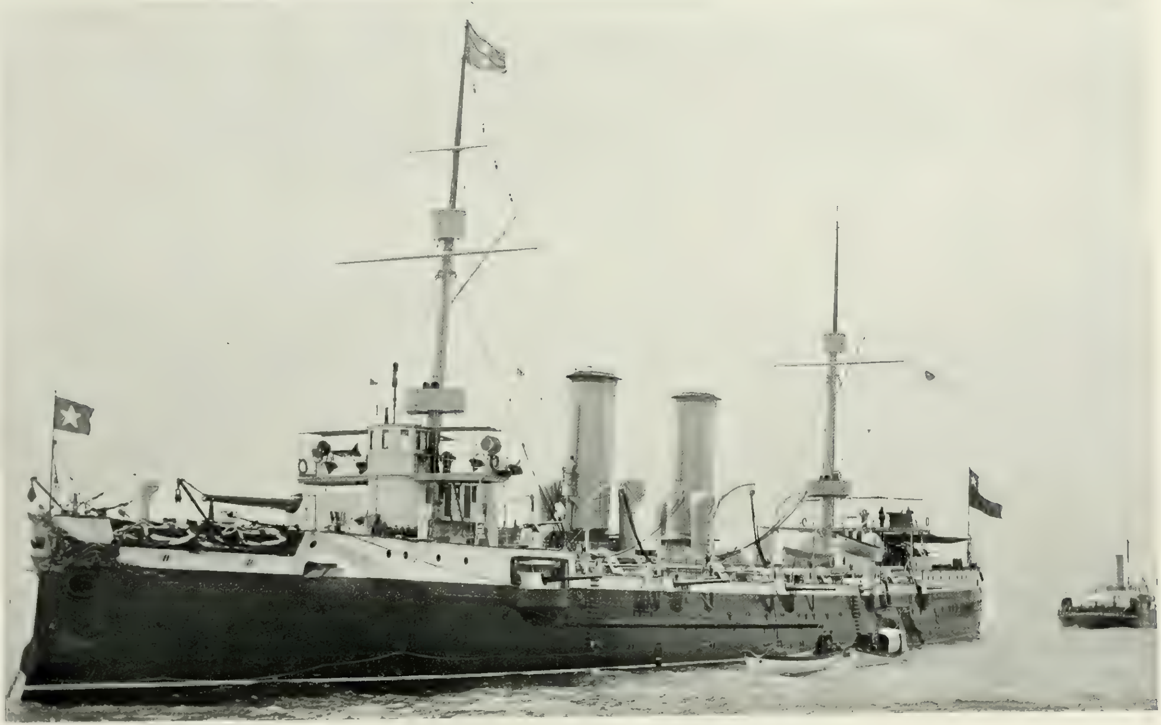


Photo by Gregory and Co., Ltd., Strand.]

THE CHILIAN CRUISER "CHACABUCO."

Built at Elswick, and only recently purchased by the Chilian Government. She is of 4,500 tons displacement, 22½ knots speed, and carries a heavy armament.

Montcalm, of 9,517 tons displacement, are—the first-named at Toulon, the second at L'Orient, where she will soon be ready for her trials, which will probably be carried out at Brest, and the third has been commissioned, and after carrying President Loubet to Cronstadt was the representative of France at Spithead the other day. This vessel is fitted with Normand-Sigaudy water-tube boilers. Her engines are intended to develop at full speed 19,600 i.h.p., giving her a speed of 21 knots. During the Russian cruise the ship maintained without difficulty a speed of 18 knots for 62 hours, and of 19 knots, occasionally increased for short intervals to 20, for 30 hours. The *Montcalm* was completed in about eighteen months from the date of her launch. Her belt armour has a maximum thickness of 6 in., and the armament comprises two 7·6 in., eight 6·4 in., and four 3·9 in. quick-firing guns. This armament has been criticised in the French papers as insufficient for her displacement. The *Condé*, *Gloire*, and *Sully*, of 10,014 tons, are —the two former at L'Orient, and the last-named at La Seyne. The *Condé* was launched on March 12th, 1902, and the *Gloire* has received her engines. The *Marseillais* and *Amiral Aube*, similar vessels, have been launched—the former at Brest in 1901, and the latter at St. Nazaire on May 9th. The *Léon Gambetta*, *Jules Ferry*, and *Victor Hugo* are on the stocks, the first-named at Brest, where she was launched in October last, the second at Cherbourg, and the third at L'Orient.

It is announced that the contracts have been signed for the construction of the vessels to be laid down this year—four battleships, to be named *Démocratie*, *Liberté*, *Justice*, and *Vérité*. One of these is to be built at Brest and three by contract. Two armoured cruisers, to be named *Jules Michelet* and *Ernest Renan*, one to be built at L'Orient and the other by contract. Two destroyers are to be built at Rochefort; thirteen submarines are to be built, eight at Toulon and five at Cherbourg; sixteen torpedo boats, one at Saigon and the others by contract.

GERMANY.

The German Naval Estimates for 1902 amount to £10,454,104, as against £9,824,685 for 1901. The five ships of the *Wittelsbach* class were launched—the ship of this name on July 3rd, 1900, and she is to be completed this year; the *Wettin*, June 6th, 1901; the *Zahringen*, June 12th, 1901; the *Mecklenburg*, November 9th, 1901; and the *Schwaben*, August 19th, 1901. These four ships are to be completed in 1903. The new battleships "H" and "I," which were laid down last year at the Germania yard at Kiel and the private establishment of Schichau, Dantzic, respectively, are to differ from the *Wittelsbach* in certain respects. The displacement is 13,200 tons, the protection will cover a larger area, the speed will be the same, and the armament will consist of four 11·02 in. guns of new type, said to be capable of firing two shots every three minutes, eighteen 7·09 in. quick-firing, and twenty-four smaller guns.

Of the armoured cruisers of the *Prinz Adalbert* class of 9,000 tons, the ship of this name, launched at Kiel in June, 1901, is to be completed next year; the *Prinz Friedrich Karl*, built at the yard of Blohm und Woss at Hamburg, was launched in July, and the *Kaiser* has been recently laid down at the Imperial yard at Kiel.

ITALY.

According to an official report submitted to the Italian Government, the sum available for the current year for the increase of the Italian Navy is £1,200,000. Of this sum, £500,000 is to be devoted to the armament of the *Regina Margherita* and *Bennedetto Brin*, battleships, and the *Francesco Ferruccio*, armoured cruiser; £400,000 is allotted for the further construction of the *Regina Elena* and *Vittorio Emmanuele III*. The balance is to be expended on torpedo cruisers and boats. The Italian Budget authorises the removal of the following vessels from the effective list of the Navy: *San Martino*, *Terrible*, *Sebastiano*, *Veniero*, *Vedetta*, *Gorgona*, *Laguna*, *Luni*, *Rondini*, *Tino*, *Tremiti*, *Malaussena*, *Marittimo*, and *Ancona*.

RUSSIA.

The Russian Naval Estimates for 1902 amount to £15,731,445, or an increase of £755,410 over those of the previous year. The battleship *Pobieda*, which has recently been at Spithead, and which is the most recent of their battleships to be completed, is particularly interesting, because she and her sisters, which are intended for service in the Far East, are regarded as embodying a combination of the qualities of the battleship and the cruiser a heavy armament and sufficient protection with a high speed. As a matter of fact, however, the speed of the *Pobieda* on trial was no more than 18·5 knots, which is about that of our modern battleships. Her engines, of 14,500 h.p., are provided with steam by thirty Belleville boilers, four of which are placed 6 ft. higher than the rest, so as to keep steam even should the furnaces of the others be flooded. She is fitted with three screws, a system in favour in several foreign navies, but not yet adopted by us. Her heaviest guns, of 10 in. calibre, and four in number, are placed in turrets fore and aft, protected by 9 in. of armour, and armoured trunks down to the belt of 10 in.; the after turret is placed lower than that forward. The secondary armament of eleven 6 in. guns is placed somewhat differently to the system adopted in previous ships. Each is in a separate protected position, four being in pairs in double sponsons at the corners of a casemate, two on the broadside, in sponsoned turrets, and one right forward in the bows. These guns are protected by from 2 to 5 in. of steel. The ship presents a large target, being high out of the water, and when running at full speed she makes a high bow wave.

UNITED STATES.

Under the provisions of the United States Naval Appropriation Bill as passed by Senate for the year 1902-3, two battleships of not more than 16,000 tons, two armoured cruisers not exceeding 14,500 tons, and two gunboats of about 1,000 tons will be built by contract. Exclusive of armament and armour, the battleships are not to exceed in cost £865,509, the cruisers £957,362, and the gunboats £78,496. An amendment was inserted instructing the Secretary of the Navy to contract with the Holland Company for five improved type submarine boats, these being an addition to the programme.

MINOR NAVIES.

The three Northern European Powers were each represented in our waters recently by a coast defence battleship, the class of vessel on which they rely principally for naval defence. The Estimates in Denmark for the Navy for the year 1901-02 amounted to £377,585, as against £380,500 for the previous year. A sister ship to the *Herluf Trolle*, to be named the *Olfert Fischer*, is under construction.

The Estimates in Sweden for the current year amount to £581,220 for the ordinary Budget and £610,170 for the extraordinary Budget, being an increase of £129,500 in the former and a decrease of £135,500 in the latter. The new coast defence battleship *Dristigheten* has concluded her steam trials satisfactorily. Her displacement is 3,450 tons; twelve Yarrow water-tube boilers give her 6,000 i.h.p. and 17 knots. Protection is afforded by a water-line belt from 8 to 4 in. in thickness. The heavy guns are in 8 in. turrets, and the secondary armament is protected by 4 in. steel. The guns carried are two 8·2 in., six 5·9 in., and fifteen 6 pounders. Three rather larger vessels of similar type were launched last year, and named the *Tapterheten*, *Vasa*, and *Acram*. They are now completing for sea. The plans for a new ship, with rather more protection, have been approved, and the three older vessels—*Svea*, *Gota*, and *Thule*—are to be re-armed.

In Norway the Estimates for the year amount to £222,700, as against £242,750 for last year. The new construction will merely consist of small craft.

OUR READERS,

And what they think of PAGE'S MAGAZINE.

WITH PORTRAITS

Photo by Lafayette, Ltd.]

RIGHT HON. W. J. PIRRIE, P.C., LL.D.

PUBLIC opinion is made up of individual units. It may, therefore, be accurately gauged by the verdict of representative men. We reproduce below some personal appreciations of PAGE'S MAGAZINE which speak for themselves.

RIGHT HON. W. J. PIRRIE, P.C., LL.D., Chairman of Harland and Wolff, Ltd., Belfast, in a letter to the Editor, says :—

> I have looked over the first number of PAGE'S MAGAZINE with much interest, especially your article in connection with the Atlantic Shipping Combine. I think your criticism is very fair, and has been dictated by a keen perception of the situation and a comprehensive knowledge of the subject as regards the International character. There is very little that I can find fault with in your article, and it is a pleasure to read one in which so much breadth of mind and grasp of the general bearings of the subject are shown. It is well to get away sometimes from the national or sentimental point of view and argue the matter out on business lines. We are a commercial nation, and it is not to our advantage to play the patriotic hymn too much.

Photo by Midgley Asquith.]

SIR HUGH GILZEAN-REID, LL.D., D.L., F.J.I.

SIR HIRAM S. MAXIM, the well-known inventor, writes :—

> I have received the first number of PAGE'S MAGAZINE, and I must say that it is quite equal to anything which I have ever seen in the way of an engineering magazine. I have been struck by the beauty of the engravings, and the remarkable scientific and literary ability of the writers, and I feel convinced that if this style is maintained, your Magazine will be sure not only to succeed, but to occupy a very high place among the engineering magazines of the world.

SIR H. GILZEAN-REID, LL.D., D.L., F.J.I., sends us an encouraging note, which has a double value when it is remembered that the writer is enabled to speak of engineering concerns, not merely from a distinguished journalistic standpoint, but also in his capacity as Director of the Newport Rolling Mills, Middlesbrough-on-Tees :—

> I have read the first number of PAGE'S MAGAZINE with interest and surprise. It seems scarcely possible to devise anything new in industrial literature. Your Magazine is a revelation. In design, matter, and execution it is distinctly original. You have produced a monthly which will speedily find, or make, a unique place and become one of the essential elements in our industrial education. It is, and will doubtless continue to be, much more than a mere record of news and sectional papers read at local societies on technical and other topics.

CHARLES M. JOHNSON, ESQ., R.N., Chief Inspector of Machinery (retired), says:—

> Permit me to congratulate you on the admirable "get-up" of PAGE'S MAGAZINE.

Photo by Maull and Fox.]

SIR HIRAM S. MAXIM.

PROFESSOR HENRY S. HELE-SHAW, LL.D., F.R.S.

HENRY S. HELE-SHAW, Esq., LL.D., F.R.S., Professor of Engineering, University College, Liverpool :—

> I must congratulate you on the excellent style in which the number is printed and illustrated, and the great interest of the contents.

SIR THOMAS SUTHERLAND, M.P., G.C.M.G., Chairman of the Peninsular and Oriental Company, and of the London Board of the Suez Canal Company, writes :—

> It is a most excellent and interesting number, full of promise for the future.

JOHN GOODMAN, Esq., M.Inst.C.E., M.I.Mech.E., Professor of Civil and Mechanical Engineering, Yorkshire College, Leeds :—

> From a brief glance through the first number of your new Magazine, it appears to me to be as good as it is possible for such a magazine to be. The "get-up" is excellent, and the matter appears to me to be just what is required in such a publication. If you only manage to keep the future copies up to such a degree of excellence I am quite sure that you will have a large circulation. Wishing you every success in your new venture.

Photo by Maull and Fox]

ADMIRAL SIR E. H. SEYMOUR, G.C.B.

JAMES A. EWING, Esq., M.A., F.R.S., LL.D., Professor of Mechanism and Applied Mechanics in the University of Cambridge, writes :—

> You are to be congratulated on the variety of its contents. I wish the new venture all the success which, to judge from the first number, it deserves.

ADMIRAL SIR E. H. SEYMOUR, G.C.B., writes :—

> That it is well and carefully compiled all will, I think, agree. The Naval Notes of course appeal most to me. They are instructive and of general interest, as they deal with various navies, and the plates showing different ships are excellent.

T. CLAXTON FIDLER, Esq., M.Inst.C.E., Professor of Engineering, University College, Dundee :—

> In these times it is refreshing to come across anything so delightful as the first number of PAGE'S MAGAZINE. The illustrations are nothing less than beautiful, while the current notices of engineering progress are all of them interesting. Even the advertisements in your hands have lost nearly all their irritating character, and I believe that people will actually look at them. In future numbers I may venture to hope that the Magazine will not be without those old-fashioned but really instructive detailed sections which are still dear to the memory of the practical draughtsman.

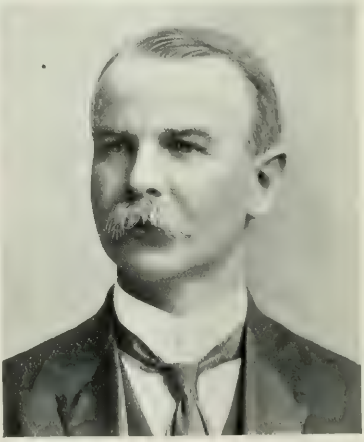


Photo by Lafayette, Ltd.

PROFESSOR JAMES A. EWING, M.A., F.R.S., LL.D.

What Our Readers Think.

Professor W. J. Ashley, who was appointed last year to the newly constituted Chair of Commerce at the Birmingham University, says :—

> I am glad to see that you propose to include articles on Business Organisation, Works Management, Cost Accounts, and the like, as well as articles on Mechanism and Processes. Hitherto the commercial and administrative sides of engineering and similar businesses have received very little systematic treatment ; and I hope we may look to you in some measure to supply the want.

James Holden, Esq., Locomotive Superintendent of the Great Eastern Railway, writes :—

> Your Magazine strikes me as being of a very comprehensive nature, yet concise and readable with profit from cover to cover.

Professor C. A. Carus-Wilson, M.A. :—

> The first number of Page's Magazine is capitally got up, and full of interest.

Photo by Herbert E. Simpson.]

PROFESSOR W. J. ASHLEY.

Photo by A. and G. Taylor.]

SIR J. FORTESCUE FLANNERY, M.P., M.INST.C.E.

Sir J. Fortescue Flannery, M.P., M.Inst.C.E., ex-President Institution of Marine Engineers, says :—

> Page's Magazine is up to date in every respect as regards engineering progress, including submarine, locomotive, electric, and workshop

Photo by Maull and Fox.]

PROFESSOR C. A. CARUS-WILSON, M.A.

practice; as regards notices of leading scientists, like Mr. Swinburne and Mr. Yerkes; and as regards the leading general engineering topics of the day, such as prime cost and organisation, the engineering branch of the Royal Navy, and short and pithy notices of the recent engineering books. In all the above it is excellent, and I wish you success in your enterprise.

JAMES STIRLING, ESQ., Government Geologist and Mining Representative of Victoria, Australia, says:—

> Judging by its first issue for July, 1902, PAGE'S MAGAZINE is likely to take a leading place among high-class industrial magazines, and will be welcomed by those engaged in all branches of mechanical, electrical, and mining engineering. It is in line with the best American publications, with beautiful photo illustrations, clear type, and excellent letterpress, printed on superior paper. The article by Mr. E. Smart on "Developments in Cyanide Practice" gives promise of considerable interest to those engaged in the treatment of auriferous tailings.

Photo by Elliott and Fry.]

JAMES STIRLING, ESQ.

Photo by H. J. Whitlock.]

PROFESSOR J. H. POYNTING, D.SC., F.R.S.

PROFESSOR J. H. POYNTING, D.Sc., F.R.S., Birmingham University:—

> It appears to me to be full of interesting matter, and I have the highest admiration for the excellent way in which the Magazine is produced. You have set yourself a very

Photo by R. S. Henderson.]

PROFESSOR W. PIPPER.

> high standard, and I heartily wish you the great success such a production deserves.

Professor William Ripper, of University College, Sheffield:—

> I have looked through your Magazine with much interest, and consider it a model of what a magazine should be, both in regard to the value of the information given in the articles and to the breadth of view shown in the general policy of the Magazine.

Commander W. C. Crutchley, F.R.G.S., Secretary of the Navy League, writes:—

> The Magazine is excellently got up, and the photographs of ships would be difficult to improve upon.

Henry Davies, Esq., Mining Lecturer to the Glamorganshire County Council, says:—

> I wish to congratulate you upon the excellence of the first number of Page's Magazine. One is convinced that there was still room for just such a Magazine as yours promises to be.

J. F. M'Intosh, Esq., Locomotive Superintendent, Caledonian Railway, writes:—

> I must congratulate you on the distinct merit of your first edition, and I have no hesitation in saying that the Magazine will be of universal interest.

Sir Alfred Hickman, M.P., D.L., ex-President of the British Iron Trade Association, says:—

> I have read with much interest the first copy of your Magazine. I think it promises to be a valuable contribution to trade literature.

Sir W. T. Doxford, M.P., the well-known shipbuilder of Sunderland, in a letter to the Editor, says:—

> The Magazine appears to be very well got up, and to be very satisfactory in many respects.

Professor Sidney H. Short says:—

> I wish to compliment you upon the excellent manner in which you have produced your new monthly, entitled Page's Magazine. The illustrations are extremely well finished, and the book generally is full of interest. I am sure that such a magazine cannot fail to meet with a wide circulation.

Professor T. E. Thorpe, writing from the Government Laboratory, Somerset House, says:—

> I congratulate you on the appearance of your Magazine. It is admirable in every respect—subject-matter, paper, printing, and illustrations—and I have no doubt that its general administration will be conducted on the lines indicated by its motto: *Qui non proficit, deficit.*[*]

The Most Hon. the Marquess of Graham, in a letter to the Editor, says:—

> The "first number" of your Magazine has been in my hands for a week; and I have now pleasure in expressing the opinion that it is a splendid production and a marvellous shillingsworth. If Page's Magazine maintains its initial reputation through the future, I have little doubt that it will excel in the line which it has cut out for its own. I would urge you most earnestly to keep prominent in its matter the best and latest information on naval affairs, and also never cease to advise and discuss the development of industries in British Colonies, especially, at the present time, those of South Africa. On these lines I wish you all success, and I believe, by adhering to them, you will assist in the best possible way true Imperial work.

T. H. Riches, Esq., J.P., Chief Locomotive and Mechanical Engineer to the Taff Vale Railway, writes:—

> A great deal of information I consider extremely useful. . . . . I think it is very thoroughly got up, and I wish you every success for its future.

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[*] He who does not advance loses ground.

IRON AND STEEL MANUFACTURE.

TRANSPORTATION OF THE MINERAL FROM MINE TO FURNACE STOCKYARD.

BY

B. H. THWAITE, C.E.

The most efficient and economic methods of transport are here discussed, with special reference to the low mineral freight rates which obtain in America. The author dealt last month with the choice of a site and the selection of ores.—Ed.

II.

THE IMPORTANCE OF EFFICIENCY IN METHODS OF TRANSPORT.

THAT success or failure in a scheme of pig iron making depends upon the efficiency and economy of transport arrangements is shown conclusively by the enormous outputs of the modern type of American blast furnaces. These have served to raise the question of transport to a position of great if not supreme importance. The immense mineral absorption capacity of these furnaces compels the provision of an adequate supply of ore in stock, and a steady and constant supply of all the minerals without any risk of intermission of supply.

The qualifications of ideal transportation are easily summarised. The operation should involve—

a. The least possible reduction of the physical size or the breaking up of the mineral.

b. The least possible waste of the minerals in transport.

c. The greatest possible efficiency of motive-power-energy in the machinery of transportation.

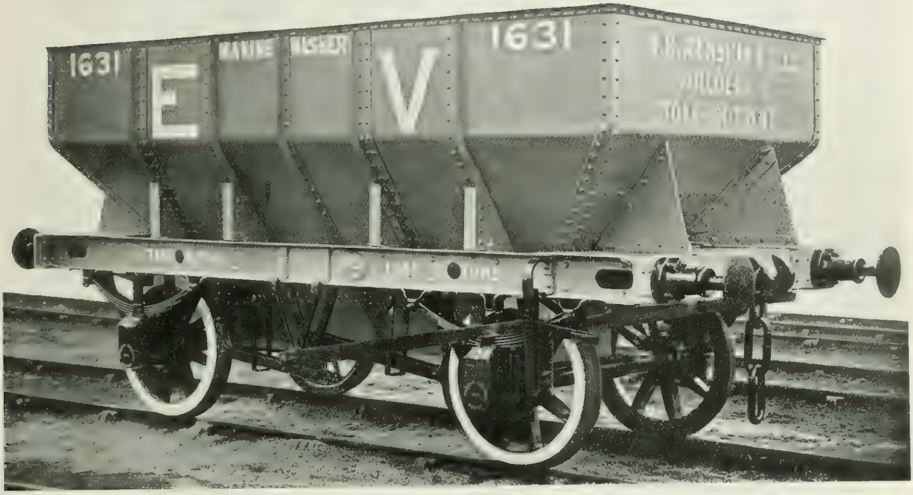
d. The least possible dependence upon *manual* labour.

e. The reduction of shunting operations to a minimum.

THE IMMENSE MINERAL ABSORPTION PROPORTIONS OF MODERN FURNACES.

In recent years—owing to the enormous proportions that the transportation of the minerals for the American furnaces have assumed—American ingenuity has been largely called upon to devise the best methods to secure the qualifications summarised—and how far they have succeeded, the reader may be able to judge from the perusal of this article.

Nearly every branch of the practical science of dynamics has been called upon to secure appropriate and cheap transportation arrangements.



ALL-STEEL HOPPER WAGGON. BUILT BY W. R. RENSHAW AND CO., LTD., STOKE-ON-TRENT.

A SYNOPSIS OF TRANSPORTATION METHODS AND AGENTS USED.

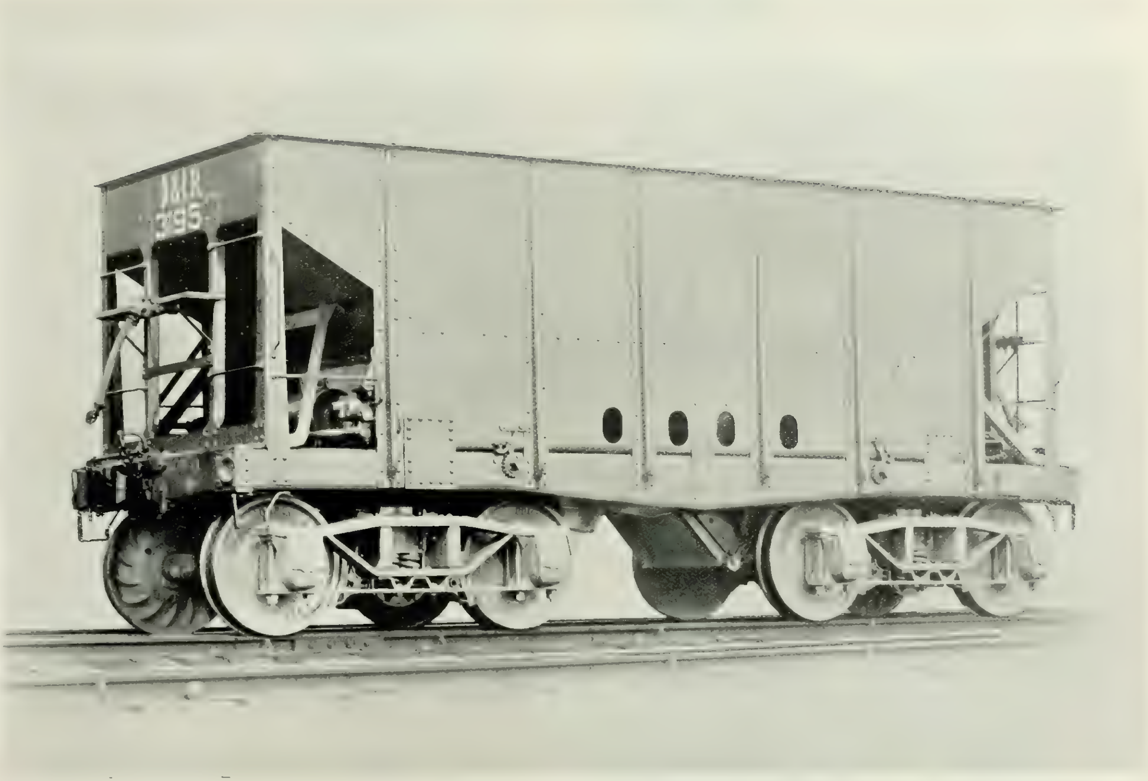
Operations.	Character of the Dynamic Process used.
Getting and transmitting the mineral to and from the railway cars.	Winding (electrical, or steam). The Steam Navvy. Hydraulic gravity effect. The tilting car method.
Transporting by land and water.	Railway cars (steam or electrical). Special ore carrying vessels. Aërial methods—direct haulage, electrical or ordinary winding.
Physical reduction.	Gates, Blake, or other equivalent crushers.
Distributing and stocking ore.	By aërial methods or by the Brown Travelling transporter.
Uniform mixing of the minerals, &c.	By rotating devices or by methods of introducing ore into mixing bins.
Elevating mineral to furnace top and effecting its introduction uniformly.	Electrical or mechanical haulage, by steam—long stroke, direct vertical acting, hydraulic ram, direct vertical lift by winding gear. Inclined hoisting system of haulage.

Besides those above enumerated, there are subsidiary divisions, calling for one or other of the resources of dynamic science; indeed, in no instance can the modern expansion of the field of dynamic operations be more fully realised than in the means adopted by American engineers for bringing the ore from the Lake Superior mines to the furnaces of the Pittsburg district.

Before proceeding to describe the operations by which the above object is secured by the latest American methods, and the apparatus included in the work of transporting the ore from the mine to the furnace, a reference may appropriately be made to the American system of rail transport of ores, and with it a brief analytical comparison between the American car and the British waggon. The author has adopted the single syllable name "car" instead of the British terms waggon or truck, both of which are less definite or conclusive than the short and expressive term "car."

THE QUESTION OF RAIL TRANSPORT.

It will be shown in these articles that the real value of this factor in the determination of the ultimate cost in producing pig-iron has been realised for years by American engineers. In



PRESSED STEEL HOPPER ORE CAR OF 50 TONS CAPACITY.

Used for carrying ore from the Mines to Lake Superior ports. Length over head-stocks, 22 feet. Maximum width, 8 feet. Height from top of rail to top of sides 9 feet 6 inches. Weight, 13 tons.
Manufactured by The Pressed Steel Car Co., 4, Clement's Lane, London, E.C.

Germany, the Government has also recognised the importance of securing transit operations at the lowest practicable cost ; and this fact has not been without its influence in the progress of the industry in that country.

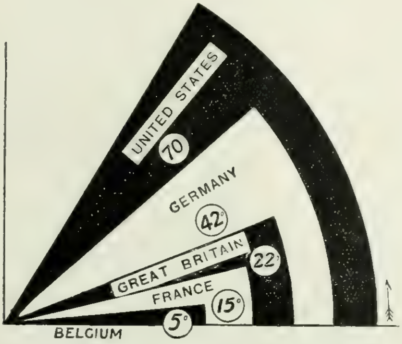


FIG. I. GRAPHIC DIAGRAM, SHOWING THE COMPARATIVE PROGRESS IN THE IRON INDUSTRY BETWEEN THE YEARS 1885 AND 1890.

The angles of inclination show the comparative progress of the United States, Germany, Great Britain, France, and Belgium.

At an important conference of traders held in 1899 in Philadelphia, a statement was made, by a speaker of great authority, to the effect that if the Americans had no *other advantage*, that of economic railway transportation alone would ultimately give them supremacy in the manufacture of iron and steel, and Americans would have (eventually) to supply the world. The accuracy of the speaker's forecast has been partly demonstrated. Whether the forecast will prove to be accurate in its entirety, depends greatly upon the British people themselves.

The following simple calculations will explain why American railway rates are low :—

THE LOW AMERICAN MINERAL FREIGHT RAILWAY RATES.

The dead or tare weight of a British standard waggon of ten tons carrying capacity is $6\frac{1}{4}$ tons, so that for a load of 40 tons the dead weight of the waggons (British pattern) would be $(\frac{40}{10} \times 6\frac{1}{4}) = 25$. As the waggons (if the traffic were of a mineral character) would have to be hauled empty on their return trip, the actual dead weight effect would be $(\frac{40}{10} \times 6\frac{1}{4})\ 2 = 50$, so that the handicap of excessive dead weight proportions applied to mineral traffic is doubled, and therefore a British train of waggons carrying 40 tons, is handicapped with a dead load of 50 tons. Now the American 40 ton capacity car would have a dead or tare load of 14 tons. This would be doubled on the return journey, and would then be equal to 28 tons. The advantages of the American system in reduction of the dead load would be represented by the equation—

$$\frac{28 \times 100}{50} = 56 \text{ per cent.}$$

As an example of the possible economy to be obtained by the reduction of the dead load ratio to the practicable minimum the following figures may be found interesting :—

THE POSSIBILITIES OF TRANSPORT REDUCTION IN FREIGHT COSTS. (AMERICAN PRACTICE.)

For the following example a train-load of minerals of 2,000 tons of freight is taken :—

	Cost per train mile traffic weight of 2,000 tons
	d.
Loco. expenses	20
Car rental and train expenses ...	$22\frac{1}{2}$
Stations and their service, including signals, etc.	6
Maintenance of permanent way and associated structures fixed at ...	$17\frac{3}{4}$
Interest on cost of railway fixed at	$17\frac{3}{4}$
Cost of returning empties	16
	100

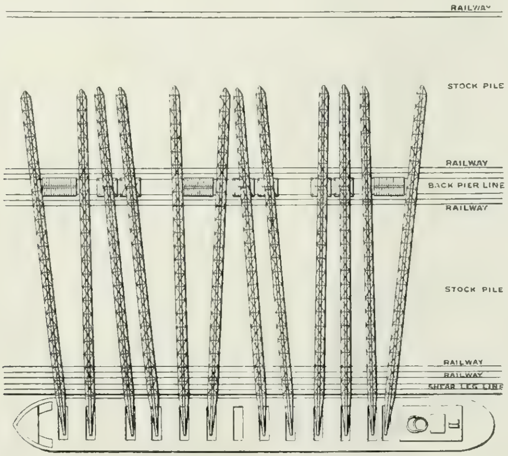
Thus on this up-to-date American freight transport line the actual net cost is equal to 1d. per ton of freight carried 20 miles, or 0·02d. per ton per mile, compared with the figure 0·75d. charged by British railway companies.

The serious drag on the transport wheels of British industry will now be fully realised, but to further emphasise the disadvantage, we will compare the difference of dead haulage weights of two freight trains of 1,000 tons of live, paying, or effective load—one British, the other American :—

		Tons of dead load.
British	$\frac{(1{,}000 \times 0{\cdot}25)}{10} \times 2$ ...	1,250
American	$\frac{(1{,}000 \times 14)}{40} \times 2$ ...	700
Reduced waste of haulage energy by American system		550

Thus for every million of tons hauled on British lines the *excess* of dead load to be carried is equal to 550,000 tons.

When the above American *v.* British comparisons are realised in their full value of importance, the surprise that the working costs of American railroads are so much less than those of British railways disappears. It is gratifying to know that the British railway administrators have at last realised the importance of reducing, for heavy mineral traffic at least, the dead load proportion of British railway rolling stock—and some of the leading British railway companies are adopting, if somewhat cautiously, the American goods traffic car proportions and rolling stock structural design—and some of our most enterprising rolling stock equipment firms have laid themselves out (and seriously) to be ready when the general movement towards the Americanisation of our British railway freight rolling stock department sets in. The Americanisation of the passenger freight department, which is now in evidence on all British main railways, will be followed by the Americanisation of their freight rolling stock.



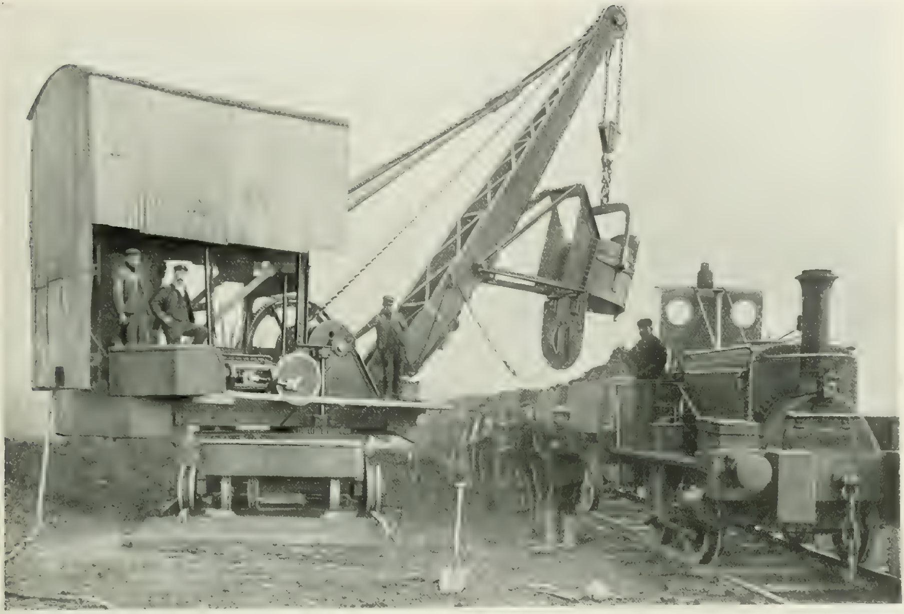
GROUP OF HOISTING BRIDGES (BROWN HOISTING COMPANY'S SYSTEM).

For the rapid transfer of the ore from lake ore ships to ore stocking bins or piles.

THE ECONOMIC VALUE OF THE DEAD LOAD PROPORTIONS.

The low dead load proportions of the American freight car are not only advantageous in reducing the waste of haulage energy, but the system to be described, by which the ore-carrying cars are bodily lifted and turned over to deposit their contents, is greatly assisted by the low proportion of the tare (or dead) to the effective load, and, whether the freight car is bodily lifted or is drawn up an incline, the loss by excessive dead load is equally the same. It is obvious that one way to secure success in an industry is to reduce the proportion of effective work to a minimum, and the dragging or haulage of the excess proportion of heavy load is one of the most inexcusable, of the too numerous existing examples of waste of energy. This is emphasised, because it demonstrates the importance of a proper design of railway sidings to secure the minimum amount of waste energy in shunting, an operation involving a great loss of energy because it includes:—

1. The overcoming of large inertia potentials.
2. The destruction of momentum.



STEAM CRANE NAVVY. BUILT BY WHITTAKER BROS., LTD., HORSFORTH, LEEDS.

Capacity about 1,000 tons per day of ten hours. If the materials to be excavated are loose a larger bucket can be put on the Navvy.

RAIL TRANSPORT EFFICIENCY.

The equation of rail transport efficiency, besides securing the maximum transit at the minimum expenditure of haulage energy, should also secure the minimum actual loss of the mineral in transit, and also the least possible alteration in the physical proportions of the ores, by the ore pulverising effect of shunting operations. The banging and clashing, inseparable from shunting operations on British lines with solid buffer waggons, are altogether fatal to high efficiency and structural durability. The organisation of the shunting operations deserves serious study, because the shunting efficiency is inversely proportionate to the distances moved by the cars—and the periods of forward and backward movement, that do not *per se* constitute the actual or direct movement of the car towards its terminal destination.

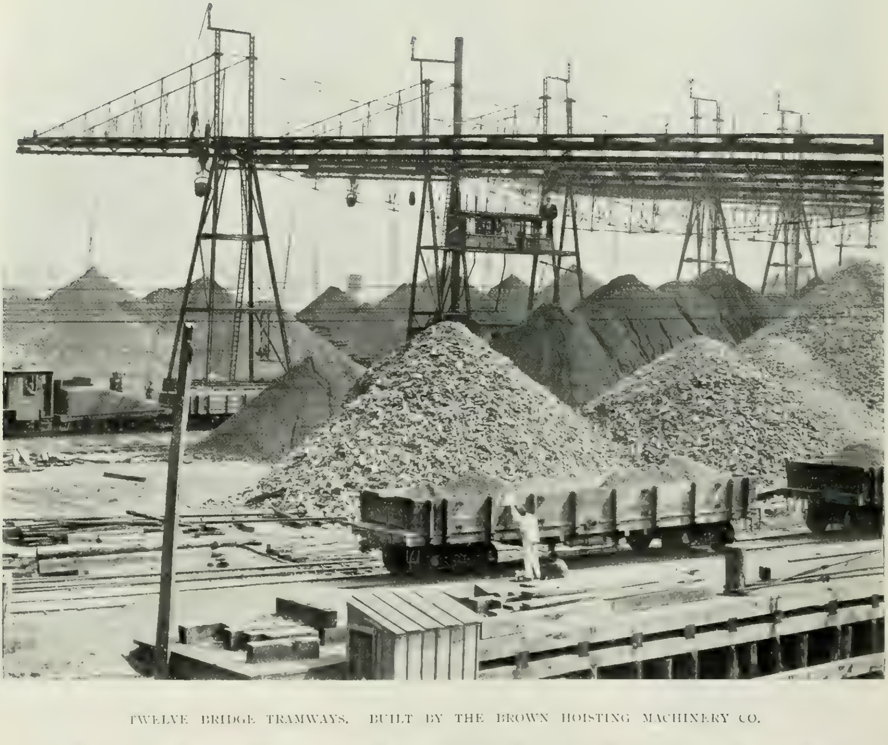
GETTING THE IRON ORE, AND TRANSPORTING IT TO THE RAILWAY CAR.

The ingenuity and appropriateness of the mechanical methods employed by the Americans in removing the iron ore from the ground to the inside of a transport car are thoroughly characteristic. It is unnecessary here to describe all the American methods of getting iron ore, they vary with the geological nature of the deposits—but the two systems often applied—the *overhead sloping* and *open cut* methods—deserve more than a passing reference. Of course, the geological character of the ore beds, and their position relative to the upper surface, should obviously determine the methods of removing the ore.

THE OVERHEAD SLOPING METHOD.

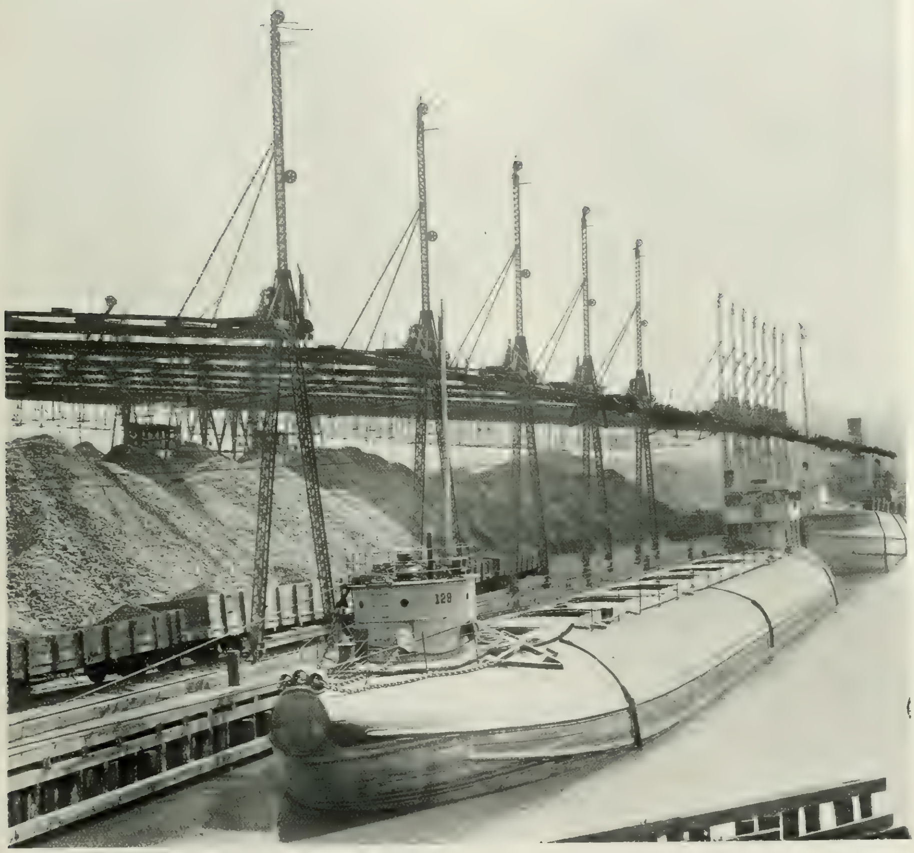
Slanting and timber-lined shafts, oblong in cross section, are sunk in the foot rock strata,

(*Continued on page 194.*)



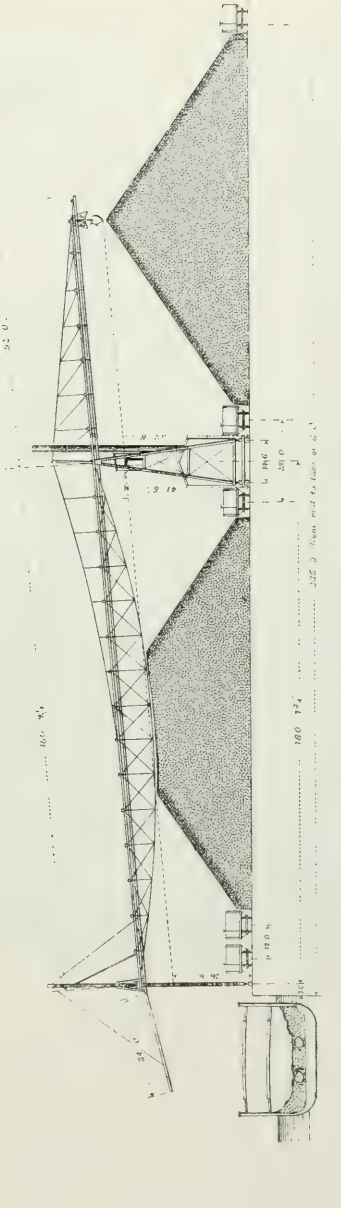
TWELVE BRIDGE TRAMWAYS. BUILT BY THE BROWN HOISTING MACHINERY CO.

These machines handle buckets having a capacity of 17½ cubic feet, or about one ton of iron ore. Each machine has three buckets, and as the men in the vessel are filling two of these buckets, the third is being emptied on the storage piles or into railway waggons



FOR THE CLEVELAND AND PITTSBURG DOCK CO., AT CLEVELAND, OHIO.

The speeds on the machines are such that they unload from vessel at the rate of about 60 tons per machine per hour and in some cases, when loading into railway waggons at the front of the quay, the capacity is even greater.



SIDE ELEVATION OF STANDARD BRIDGE TRAMWAY PLANT.

(Continued from page 101.)

and follow its dip; the main shaft may be divided for two purposes—one for pumping, the other for winding; and from this shaft headings are driven horizontally across the ore deposit zone, each drive, which is timbered, having other branches at right angles to it. When sufficient drives have been made, dynamite is used—a collapse following produces a cave, and the ore is then easily removable.

OPEN CUT METHOD.

By the exposure of the ore bed either naturally or by direct excavation and blasting operations *—in such a way as to permit of the use of powerful mechanical means—the removal of the ore is made possible under ideal conditions, both in economy *and* in speed of operation; and for this purpose an adaptation of the Bucket Excavator or Steam Navvy has been used with the greatest success. The ordinary capacity of a first-class modern American type of Steam Navvy is the removal and depositing in rail car of *fifty tons* of ore in *five minutes.*

As the labour involved in working the excavation is equal to nine or ten men, this is therefore equivalent to the removal of six tons of ore into truck, per hour, per man. The consumption of fuel, ordinary American steam coal, is ¾ lb. per ton of ore removed and deposited in car. The holding capacity of the bucket is three to four tons of ore. †

The railway sidings of the Lake Superior Ore Fields, are well designed to secure the least possible useless expenditure of haulage energy. See fig. 2, which is sufficiently self-explanatory.

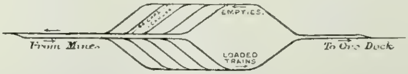


FIG. 2. SCHEME OF SORTING SIDING TO PERMIT THE RAPID DISCHARGE OF COMPLETE ORE FREIGHT TRAINS. EACH SIDING IS SUFFICIENTLY LONG TO PERMIT A COMPLETE TRAIN TO BE SHUNTED ON TO IT.

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[*] To effect the removal by blasting methods dynamite charges are introduced into a drilled 1¼ in. hole, at the foot of which is a considerable weight, say ½ cwt., of black powder.

† Large chunks of ore are physically reduced, by means of powerful Gates crushers so arranged that the reduced ore falls direct into the car. The Steam Navvy is also employed for the accumulations of stock ore. The apparatus enables ore to be loaded on to the stock heaps and reloaded into cars for a few pence per ton.

Proper rail siding arrangements are an essential condition to the fullest possible efficiency of this Steam Navvy System of ore-getting. A rail siding is laid down alongside the ore-exposed cutting, and is extended as required; alongside this Steam Navvy siding, is the freight car siding, which is laid down within the sweep of the jib of the Steam Navvy.

FROM MINE TO LAKE STEAMER.

The Lake Superior ore is transmitted by rail to the borders of the Lakes. The cars are run along specially constructed jetties, 2,000 ft. in length, and having four lines of rails. The construction of the jetties is clearly indicated in figs. 3 and 4, which show respectively a cross-section of the jetty and a plan. The jetty includes in its construction ore-reception bins, so arranged that the cars can deposit their ore freight direct into these bins (the floors of which are inclined right and left) at an angle of 45 deg. The ore thus gravitates to the shoots, by which it falls into the hatchways of the transporting vessel. The bins have a capacity adequate to store the contents of three fifty-ton capacity cars.

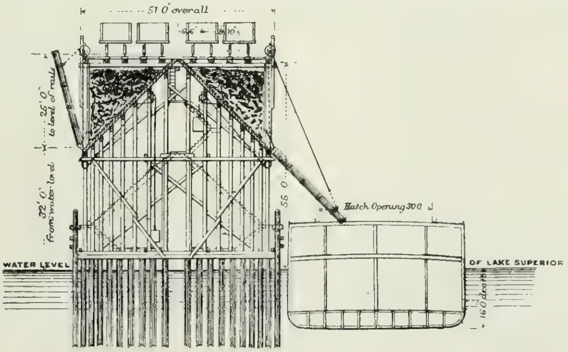

FIG. 3. ORE-DISCHARGE JETTY AND ITS ORE BINS.
Illustrating method of discharge direct into hatchway of ore vessel

The hatchways on the transporting vessel correspond in position with the shoots of the jetty bins, and it is possible to discharge a train of high-capacity cars of 1,800 tons in a few minutes.

In a typically proportioned vessel the hatchways are positioned 24 ft. from centre to centre. The ore bins of the pier are 12 ft. from centre to centre. When one set of bins has had its contents discharged into the hatchways of the transport vessel, the latter is moved forward so that the intermediate bins can be discharged. It will be noticed on referring to fig. 3 that two trains of cars can simultaneonsly discharge their ore contents into the jetty bins. The rate of discharge is rather slower than that of the cars into the bins, but it is possible to transfer 1,600 tons of iron ore into the transporting vessel in one hour.

DETERMINING THE METALLIC CONTENTS OF THE ORE BEFORE SHIPMENT.

On the Lake Superior Ore Fields, representative samples of ore are collected for analysis, and a well-equipped laboratory enables such analysis* to be effected immediately the cars with their contents are weighed, and before leaving the sidings and shipping ports. As the construction of the American freight cars is of the best, and is steel throughout, the variations of the tare are very slight compared with those of the miserable type of waggon used in this country. Where it is necessary to convey the ore to the freight transport train, by means of a chain conveyor, it is now possible to secure the weight measurement of the ore during its motion along such conveyor, both automatically and with sufficient accuracy, by

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* The ore to be analysed is selected from 4,000 samples made up into 5 cwt. lots.

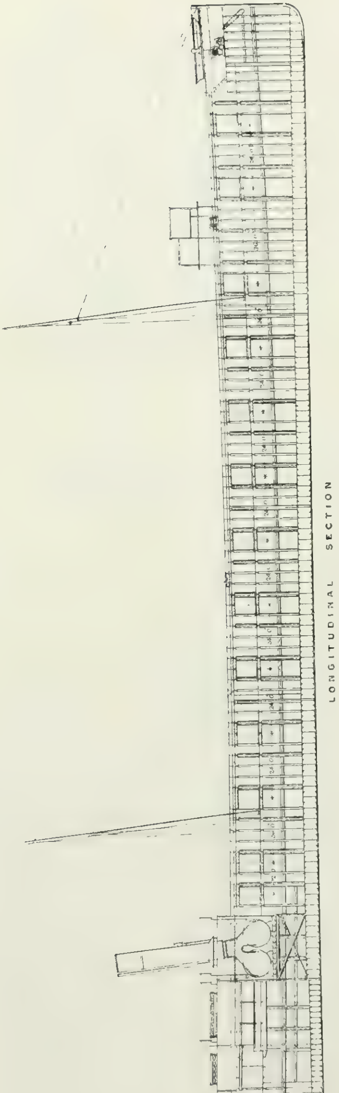


FIG. 5. SHALLOW DRAFT LAKE ORE SHIP.
Loading capacity [illegible] tons.

means of Messrs. Denison's Automatic System, which will be fully described in the appendix to these articles.

On referring to the figs. 3 and 4, it will be noticed that the hatchway openings of the Lake Superior ore-carrying vessels are equipped with trimmer plates, and the variation of the degree of inclination of these plates permits the even trimming of the ore stock in the cargo space. So extensive are the Lake Superior ore-discharge jetties that twenty ore-carrying vessels can take in cargo at the same time.

Fig. 5 shows a longitudinal section of a typical lake Lake Superior ore-carrying vessel.

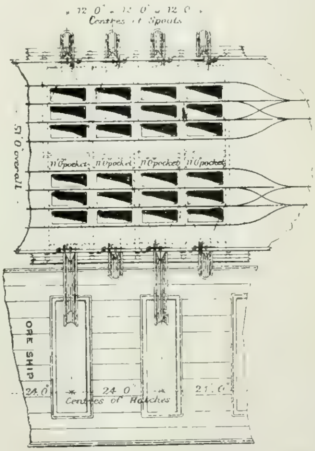
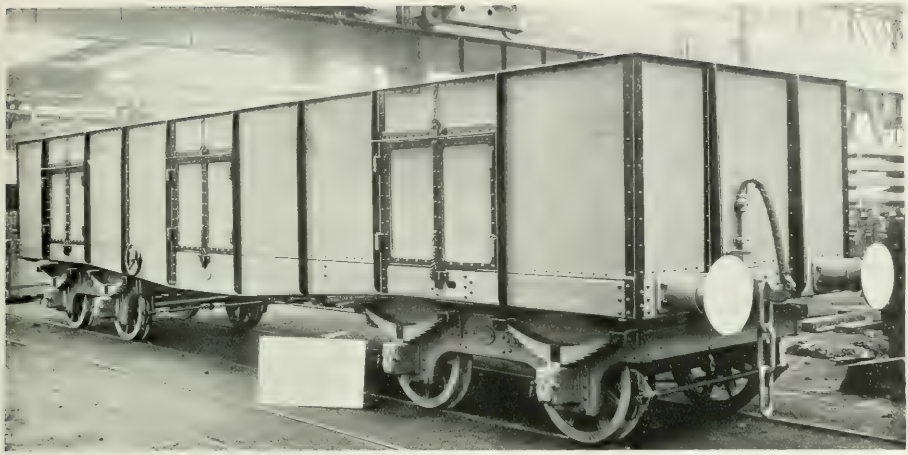


FIG. 4. PLAN, SHOWING ORE-DISCHARGE JETTY WITH THEIR ORE BINS, AND PART OF THE LAKE ORE VESSELS AND THEIR HATCHWAYS.

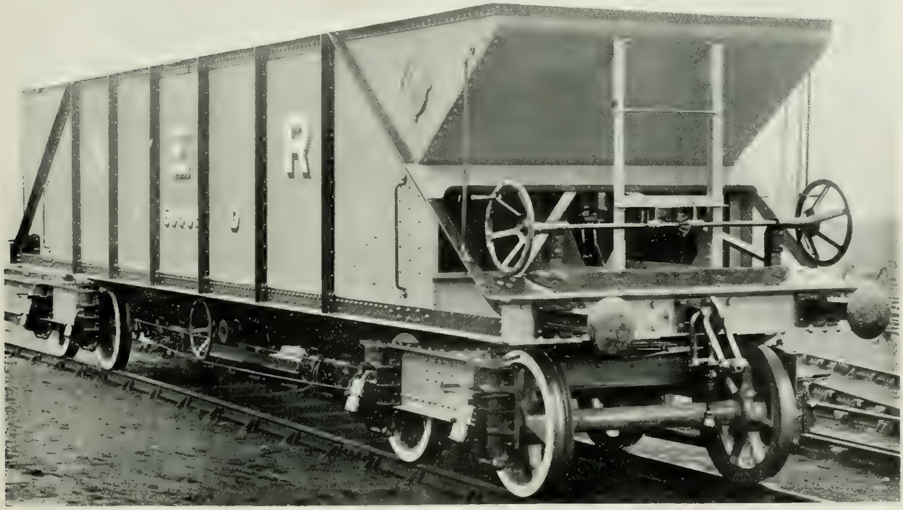
FROM LAKE STEAMER TO IRON WORKS.

It may be formulated as an axiom in the good management of an up-to-date freight railway that, in proportion to the efficiency and perfection of the mineral rolling stock, is it advisable to immediately discharge the contents of the freight cars, so that they can be brought into constant service for transport purposes, instead of being stationed in sidings to serve as mere ore-storage bins. The importance of this axiom is realised in America, and in the mineral freight transportation arrangements every precaution is taken to rapidly charge the mineral cars.



HIGH CAPACITY ALL-STEEL 30-TON BOGIE WAGGON. BUILT BY THE LEEDS FORGE CO., LTD., LEEDS.

This firm are at present executing an order from the Midland Railway Company for 30-ton waggons, similarly arranged to the one illustrated, with three openings on each side, and also some 40-ton all-steel self-discharging waggons for the North Eastern Railway.



DOUBLE HOPPER WAGGON OF 32 TONS CAPACITY. DESIGNED BY MESSRS. SHEFFIELD AND TWINBERROW, NEWCASTLE-ON-TYNE.

A number are at work in the export coal traffic in the Newcastle district, and the Darlington Waggon Company have in hand a further order in which the capacity is increased to 40 tons by an addition of 12 in. to the height.

INTERNATIONAL PATENT MONOPOLIES.

BY

JAMES SWINBURNE,

President of the Institution of Electrical Engineers; M.Inst.C.E., M.I.Mech.E., etc.

ARGUMENT. What a patent monopoly is. A bargain with the public, not a right. Analogy with copyright. Progress hindered by international patent laws. A patented invention not developed till the patent runs out. An invention patented in one country only would be developed quickly in others. International patents not the result of national altruism. Patents a means of taxing by fees. The politician. Giving foreigners patents does each country harm. Patent laws of different countries unfair to one another, especially to England. England the most inventive nation. Patent laws of various countries should give equal monopolies.

IT may be as well first to consider what a patent monopoly really is. Originally there was a desire on the part of the Government to encourage trades in this country which were already flourishing abroad. Thus, in order to induce foreign weavers to come over and settle in England, they were given a monopoly of manufacture in this country for a time on condition that they taught our people to weave, so that at the end of the time we should have a weaving industry established. Anyone who thus introduced a new manufacture and taught the nation how to carry it on was rewarded with a monopoly for a term of years. It was not necessary that the new manufacture should be imported from abroad; it might be invented, and an originator was entitled to his monopoly as much as an introducer; and the word "inventor" in English patent law covers the introducer of a manufacture already known abroad, as well as the originator of a new industry. Such, very shortly, is the history of patent monopolies.

A QUESTION OF BARGAIN.

It is often assumed by inventors that they have some specific and unquestionable right to the fruits of their inventions. This is not so at all. It is merely a question of bargain between the public and the inventor. The public says "We want new manufactures, and to encourage their introduction we will give prizes to their introducers." Copyright is an analogous case. The author has no necessary right in his productions. The public merely gives him a monopoly to induce him to write. The monopoly is really to facilitate publishing. If there were no copyright laws it would not pay to publish a book, because if, as usual, bad, the publisher would lose; while if it happened to be good, others would publish a cheap edition at once. Though the author is necessary in the production of a good book, and though he gets all the credit if the book is successful, the publisher is a much more important element, as he has the main financial risk, and his few successes have to cover his numerous failures. The author and the publisher have to work together and advertise the author. The reputation of a modern author is made in the same way as that of a manufacturer, and the familiarity of the sound of a novelist's name is really no more fame than that of the maker of a popular soap.

Copyright differs essentially from patent right, however. A patentee prevents others from doing what they would like in the way of producing improvements on his invention, but an author or painter or composer does not prevent anyone from doing anything he was free to do before. The publisher, including the author, thus has a much longer monopoly as a reward. It is a question whether the monopoly given by copyright is not much too long.

Patent copyrights are thus merely a bargain with the public. The public offers a reward to encourage new manufactures. The inventor has no inherent right to the product of his brains any more than if he chances upon the idea of introducing a new flower, or a new breed of cattle.

EFFECT OF EXTENDED MONOPOLIES.

The original reward granted for introducing a new manufacture was a monopoly of fourteen years in a country of very few inhabitants, in which manufacture was but little developed. Now, an inventor, for a consideration, can get a monopoly of from fourteen to seventeen years, not only in his own country, but in almost all the civilised countries of the globe, an enormously greater monopoly than was ever dreamt of in the time of James I. It is open to question whether inventors have not in general far too great a monoply for the good of the public, and even in most cases for their own good.

Let us consider what would happen if inventors were only allowed to have patents in their own countries, or say in one country. To take a concrete case, let us deal with the inventor of, say, a successful flying machine. Of course there are thousands of inventors of flying machines, and it is said that the seedy and often somnolent gentlemen who are to be found in numbers in the patent office library in winter are inventors of flying machines who come in for warmth. But we will imagine the future inventor of the flying machine which really works. If he can patent it in all the civilised countries in the world he prevents, or at least strongly discourages, other people from making improvements; because they cannot use the improvements without licenses, and he will not adopt and pay for them himself because an inventor hates improvements made by other people. Now, an inventor is generally the last person capable of making further progress. In the first place, if the invention, like that of the flying machine taken as an example, is fundamental, the chances are that the inventor is an ignorant man who has stumbled upon a new thing. Such an inventor is generally incapable of making any further advances. Inventors may be divided into two classes : the ignorant but often very pertinacious inventor who stumbles on something without being able to give any clear reason how he got there, and the trained designer who, having found what was wanted, sets to work to fill the want by carefully considering the best means to the end. The epoch-making inventor is generally of the first kind. The man who improves and develops the idea is generally of the second. Now, the wild inventor is not only unable to advance his invention, but he is generally impossible to deal with, and hopelessly unbusinesslike. People who finance inventors seldom realise until too late that most of them should be rigidly excluded from the factory, and the inventor generally makes his own success impossible by his want of business knowledge, and his vanity, which prevents his adopting improvements suggested by his assistants. Even the intelligent inventor who merely uses a very extensive knowledge to make improvements in a logical way is often unable to develop his invention. His ideas generally get crystallised, and his thoughts work in a circle. The result is that an invention seldom makes much progress until the patents are run out. The public, whom we are for the moment taking the unusual course of considering, are thus deprived of the full benefit of the invention for the term of the monopoly.

Suppose, on the other hand, each patent could only be taken out in one country, the inventor of the flying machine would soon see enormous advances made in his invention in other countries. Each improvement would be protected in one other country, but not in his. None of these improvements would be patented in his country, but his patent would cover their use. He would thus do an enormous business, as his manufactures would be developed very quickly at little outlay to him, and his income would, no doubt, be made much larger than if he had taken out patents all over the world.

Each of the inventors of improvements would reap a large reward in the country where he had patented it, as he could use all the improvements patented in other countries. The result would be that the inventors would all be well satisfied; but, what is more important, the public in all the countries would be supplied with well-designed and thoroughly-worked-out machines almost at once, instead of having to wait until the patents ran out before beginning to develop the invention seriously.

It must be admitted at once that there are many inventions which deserve international patents and long-time monopolies, while others should be limited in both respects.

ORIGIN OF INTERNATIONAL PATENT MONOPOLIES.

We may now consider how international patent monopolies have come to exist. The idea is that the nations all came together and discussed the matter, and arranged a system for the common good of their peoples. Unfortunately Governments do not work quite in that way. There is no real agreement of that sort; neither is there a universal arrangement of give and take. For instance, we grant patents in England to Dutchmen, but there is no patent law in Holland; so they do not grant an Englishman a patent there. Similarly, we granted patents here to Swiss inventors before there was any patent laws in Switzerland.

The question then arises, Why do we grant patents to foreigners? If an American or a Frenchman invents something, why do we not copy it and make it wholesale, and thus get the benefit of the invention? It may be said this would be a sort of theft. Not at all! If a foreign Government chooses to encourage local invention by giving a monopoly to the inventor, that is the business of the foreign country. We need not increase his reward at our special expense. Again, Switzerland was not a piratical republic before it had its patent laws, and the Dutch are not pirates or anything iniquitous because they have none. Similarly, the Americans are quite justified in reprinting English publications under their law. The English writer had his full payment for his work in his English monopoly, and there was no need for America to step in and add to it at American expense. The ability to take out foreign patents is not a great spur to invention in any country, and it is probable that no advance has owed its existence to the chance of taking out foreign patents for it.

A CONVENIENT SOURCE OF TAXATION.

Then why do countries grant patents to foreigners? The answer is simple. It is a convenient means of taxing. Nations do not work together with the love of brothers. It is held by many that international morality not only does not, but ought not, to exist. That whatever may be the code of ethics for private individuals, nations should be guided in their relations solely by force and cunning, each considering itself only. If countries agreed to make their patent laws for their common benefit, this might be an exception to the rule, but, as will be shown presently, nations do not make their patent laws on fair principles.

THEIR UTILITY TO THE POLITICIAN.

But consider the position of the public man or politician. He has to raise a certain amount of money in taxes. Though he wastes most of it, it has all to be raised, and it must be raised in the way that makes the politician as little unpopular as possible. He must especially avoid taxing in such a way as to annoy his constituents. It does not matter in the least whom the taxes really fall upon, as long as his supporters imagine they do not fall on them. The real incidence of taxes is exceedingly difficult to follow out. The politician, therefore, puts an indirect tax on industry. The Post Office is a flagrant example. It makes a large profit, which is handed over to the politicians to spend. The Post Office is generally proud of this, and boasts of it as showing good management, and the politician pretends to be proud of it, too; but he cannot really be proud of anything he does. That the messenger business, in spite of its being worked by a Government department, should make a large profit shows that industry is being shamefully taxed. It is the same with the Patent Office. The politician arranges the fees so that there is a large surplus which comes into his hands. The fees are enormously swelled by foreign applications. It is thus to the politician's interest to allow patents to foreigners, and he is not the least concerned with the question whether patents to foreigners are good for the nation. All he wants is that his party shall not blame him. National prosperity does not matter.

PAST AND PRESENT MONOPOLIES.

It must not be supposed that granting patents to foreigners began in this way. In England we did not begin with a system of patents for Englishmen only, and then suddenly throw the door open to foreigners with the view of increasing the revenue by a large surplus from the Patent Office. On the contrary, the early patents were granted to foreigners, who introduced Continental industries. But introducing a foreign industry which would otherwise remain unknown to us by starting a manufacture which employs English labour is one thing; inventing something abroad, which, with modern communications, we would know about at once, and then sending the article over at an enhanced price, is another. In one case an industry is started—say, in weaving—which would not otherwise have begun, and instead of buying our cloth at a high price we make it ourselves. In the modern case we are prevented from making it ourselves, and have to buy it from abroad at a high price. The modern patent granted to a foreigner has thus exactly the opposite effect of the monopoly originally intended. Some countries insist upon the manufacture being carried out in the country within a fixed time, and some do not allow importation of a patented article. This is sound from the nation's own point of view, but it would be better still not to grant the foreigner any patent at all.

EFFECT ON INDIVIDUAL COUNTRIES.

If we consider such a country as Holland, there is no reason for a patent law. The population of Holland is only a small fraction of that of the civilised world. The Dutch get all the advantages of all the inventions of the rest of the world, without any patent law of any kind of their own. If they grant patents to the Dutch only, they increase the encouragement to Dutch inventors. At first sight it might be said that as the Dutch have already all the encouragement due to all the foreign patent offices, the addition of Dutch patents would not make much difference. It would only add a small percentage of encouragement. But this is hardly the case. A patent in a man's own country, where he can develop and work the invention is much more important to him than a grant in a foreign land. If the Dutch, therefore, granted patents to their own people they would thus encourage Dutch invention a little. But they would encourage invention as a whole very little, because the Dutch are a small proportion of the whole, and they have the advantage of all the inventions due to external encouragement. There is thus little use in their granting home patents. But for them to grant patents to foreigners is for them wilfully to deprive themselves of all the advantages of other nations' experience. If they grant foreign patents, and allow foreigners to send their patented articles into Holland, they are wilfully depriving their own people of the chance of making these articles, and making them buy them at a fancy, or at any rate enhanced, value, from other countries. If they do not allow importation of the foreign patented article, but insist on its being made in Holland as a condition of the patent, the article will be made in Holland, and Dutchmen will be employed, but the public will have to pay extra, as royalty, and will probably also be badly supplied. There can thus be no sort of advantage to Holland in framing a patent law which gives foreigners monoplies there, but its politicians may, at any time realise that a patent office can be arranged to tax the native inventors, or to tax the nations' industry without the public realising what is really happening. The politicians make a number of speeches about the enormous benefits of good patent laws to the industry of the nation, and when people believe that any kind of patent law is a good thing, laws are made and fees are settled which bring in large revenues. Then the politician and the department say "Look how magnificently we manage; we are actually working at a huge profit, which all comes from Heaven, and what is left after satisfying our little needs goes to reduce your taxes."

What possessed a sensible country like Switzerland, with a rapidly developing engineering industry, to cut itself off from the use of foreign inventions? There was a lot of tall talk at the time about patent monopolies encouraging industry, and the Swiss public, in spite of its not really consisting entirely of polyglot waiters, was probably as easily gulled by the politician as any other kind of weak humanity. The Swiss have, of course, taken a very active part in the Convention, a movement in accordance with which nations are to deal with one another on moral principles as far as patents go. It may be, therefore, that Switzerland considered it nationally immoral to utilise the inventions of other countries without paying for them, but it is much more likely the real effects of their patent law on themselves was not considered.

So far we have been considering international patent monopolies from the point of view of each nation considered separately, and it has been pointed out that each country hurts itself by granting patents to foreigners. As far as I know, this view of the case is new, but it is none the less likely to be true. The other and more extreme view put forward—that it would be better for industry generally, and even for individual patentees, if an inventor could only take out a patent in one country—is open to much discussion.

UNFAIR PATENT LAWS.

Taking the view that each nation must look after its own interests exclusively—and while we have armies and navies it must be admitted there is some foundation for the notion—it is clearly against public interest in each country to allow foreigners to patent at all. But let us take the other view, and consider the question on the assumption that the nations, out of pure love for one another, meet and frame patent laws for the general good, and arrange fees so that invention is never taxed. Or we may consider that the nations realise that a bargain is useful to each if it is useful to all. Then there is very serious fault to be found with the patent laws. To be fair, either each nation should give its own people an advantage, and the advantage should be the same in all cases, or natives and foreigners should be treated alike. But, in fact, the patent laws are different in different countries, and we are alone, or almost alone, in giving foreigners the same privileges as our own people. The patent laws of various countries are exceedingly unfair, and we as a nation suffer most.

WHAT ENGLAND GIVES.

Making patenting easy for all increases the patent fees of the country, and pleases the politician, but it does so by hampering us, while English inventors do not get the corresponding privileges abroad. It also presses much harder upon us because we are still the most inventive nation of the world. Taking the large countries, America may be ahead of us in working out labour-saving devices, and designing machines for manufacture on a wholesale plan; but American inventions nearly all arise from labour considerations, and mostly consist of careful adaptation of known means to known ends, involving ingenuity and labour in design, but needing no striking originality. Germany, and to some extent France, is professor ridden, and education by pedagogue, though it may lead to great book knowledge of what others have done, seems to prevent original thought and broad views. In this country our fault is if anything on the other side. The university professor and scientific society view of the relations of knowledge to industry does immense harm here, for it cripples the advance of real science, and brings it into disrepute among serious producers, but it has largely saved technology from the domination of the book-trained pedagogue by discrediting him, and as inventors we gain an advantage. If we could sweep the priggishness out of conventional science here, and have our engineers educated by engineers with a broad knowledge of real science, we would be better off still; but we cannot complain as it is.

WHAT ENGLAND GETS.

But while we put the foreigner on terms of equality in our patent practice, we do not receive fair treatment abroad. America, for instance, will not grant a foreigner a patent if he has taken out a foreign patent before. The foreigner naturally takes out his patent in his own country first. The American thus has an advantage here. In addition, they wilfully misread English law. A patent is not granted in England until the sealing, but the American Patent Office interprets the law as if the patent were granted when the provisional application is filed. It thus deprives Englishmen of patents unfairly. Then an American has other advantages in proving date of invention and in filing caveats. In many of the Continental countries, the inventor, or at least his applicant, must be "domiciled" in the country. This gives rise to vexatious difficulties. By far the most serious matter, however, is the proviso some Governments make that patents shall be worked in the country.

A foreign inventor must manufacture in France, for instance, and after a short period he may not take his imported article into that country, it must all be made there. If this law is enforced in one country alone it is good for that country, as it reduces foreign patents, and ensures that home labour shall be employed. From an economical point of view it does not follow that it is better for a country to have its own factory rather than buy cheaper from outside. Taking all countries into account it is obviously better to have, for instance, large works in France making typewriters for France and Germany and a large works in Germany making sewing machines for Germany and France than two small factories in each. But politicians' economics do not generally lead them to that way of thinking. But it is obviously unfair for other countries to give Frenchmen patents on the same terms as their own people while France puts difficulties like that in their way in return. It often means that French patents cannot be maintained because it frequently takes many years to establish an industry when an invention is very novel in character. It may be urged that the idea is that unless a patent is worked it should be invalidated so as to allow others to use it. But that would be met by its being worked anywhere. The law of working is said to be carried out so rigidly, that an inventor of a torpedo for blowing up ironclads found that, in order to keep his patent in force, he had to blow up an ironclad once a year in each of several Continental countries.

WANTED FAIR DEALING.

There are a large number of smaller regulations and points which make it especially difficult for Englishmen to take out foreign patents; but there can be no doubt that nothing is done by foreign Governments with any view of being in any way hostile to England in particular. The main difficulty is that we give foreigners advantages that other countries do not, and so we suffer.

It is too much to hope that we may give up granting patents to foreigners, but certainly it is not too much to ask that other countries should give us the same facilities as we give them. There are so many reforms needed in patent law, not only abroad, but in this country, that very drastic changes will have to be made. Anxiety is allayed from time to time by Parliament making some minute alteration with much trumpeting. In fact, there is a small Bill, or billule, going to be exhibited soon.

LOCOMOTIVE ENGINEERING NOTES.

The New Great Western Locomotive Superintendency.

THE appointment of Mr. G. J. Churchward to the locomotive superintendency of the Great Western Railway on the retirement of Mr. W. Dean, after many years of valuable service, brings a new figure upon the stage of one of the most important railways of Great Britain—the one, indeed, possessing both the largest mileage of any and the longest distance between its extreme termini. It is well known that for some time past Mr. Churchward, as second in command at Swindon, has had a very substantial part in the conduct of the Great Western's locomotive department, owing to the failing health of his chief, and it is believed by many that his influence may be seen in some of the more recent and striking designs of which that railway has of late been so prolific. Time will show how far these designs reflect the views of the new locomotive superintendent. For the present it is sufficient to offer him all good wishes for a successful and pleasant career in the important position he has been called upon to fill while still relatively a young man.

The Drummond Spark-Arrester.

Publication has been given to some interesting details of the effects of spark-arresting apparatus invented by Mr. Dugald Drummond, and applied by him to his engines on the London and South-Western Railway. It will be remembered that this apparatus consists mainly of what may be described as a pair of hinged metal wings or flaps in the smoke-box, which intercept and deflect all ignited matter that has been projected through the tubes, while they are alleged not to operate detrimentally upon the steaming capacity of the locomotive. It should be noted, however, that the trains which furnished the basis of the published results appear to have been what may be called "semi-fast" or fast-stopping trains, and not the most important expresses. Thus, while the results shown appear to be quite satisfactory, so far as they go, they throw no light on the question whether the engines fitted with these spark-arresters can keep time with really fast and heavy express trains. Hitherto, the difficulty with all spark-arresting appliances has been that, although they may have succeeded in intercepting the sparks—which is a comparatively easy matter—they have *pro tanto* impeded the generation of steam.

Do they affect the Engine's Steaming?

It is claimed, and doubtless with justice, on behalf of Mr. Drummond's apparatus, that while entirely preventing the escape of all sparks large enough to possess incendiary capacities, it also admits of a substantial saving in the consumption of fuel. This may very well be the case, but the real question is whether the fuel economy is or is not gained at the expense of punctuality. It is not difficult to arrest sparks or to save coal if either or both of these advantages be obtained at the cost of time lost by the engine. At present no information has been forthcoming on this head. Therefore, while it is not asserted or intended to be implied that Mr. Drummond's spark-arresting engines *do* lose time when hauling heavy or fast expresses, there is nothing as yet to show that they do *not*, and authoritative information on this head is urgently desirable if what seems *primâ facie* a most valuable invention, is to obtain the general acceptance which on its apparent merits it would seem to deserve. Fire-throwing by locomotives has long been a serious trouble to railway companies, and a heavy expense, too. If Mr. Drummond has mastered the problem of averting this nuisance without doing so at the expense of the engine's efficiency, he has achieved a most useful feat, for which all railway companies should be profoundly thankful.

Mr. Drummond's Water-Tube Fireboxes.

His water-tube fireboxes appear to have proved a distinct success in actual practice; and that they materially enhance the steam generative capacity of the engine there can be little doubt. The question is, whether they do so to an extent commensurate with the additional construction-cost involved. Here, again, it is not alleged or implied that such is not the case; but, manifestly, the possibility is one which must be borne in mind when estimating the value of the device or considering the advisability of its general adoption.

The French "Bouilleur" System.

The somewhat analogous plan viz., the water-arch, or *bouilleur*, tried on several French railways has been largely abandoned on the ground that the cost of its upkeep and replacement when worn out was in excess relatively of its value as an adjunct to the steam generative capacity of the locomotive. Of course, it does not at all follow, because the French *bouilleur* has proved of dubious or negative value, that Mr. Drummond's water-tube firebox is in any way unsatisfactory. Indeed, it appears to possess marked superiority, alike in theory and in practice, to the French method It fulfils the first and chief desideratum in methods of steam generation that the receptacles of the water which is to be converted into steam should be exposed as much as possible to the direct action of the fire, while it necessarily improves the effectiveness of the most important portion of a locomotive's steam-generating apparatus—the firebox. Thus it certainly merits the careful attention of all locomotive engineers.

The Marshall Valve-Gear.

Adequate information is still lacking in the case of the Marshall valve-gear, of which so much was heard a few months ago. It is understood, however, that experiments are still in progress with this gear in the case of both express and goods engines, and that more will probably be known shortly as to the extent to which it actually realises the very sanguine anticipations of its inventor and his backers. It may be taken for granted that it will receive a fair and thorough trial at the hands of Mr. H. A. Ivatt on the Great Northern Railway.

Mr. Webb's Four-cylinder Compounds.

Mr. F.W. Webb's four-cylinder compounds, both of the "Jubilee" and of the "Alfred" classes, seem to be doing excellent service on the London and North-Western Railway, and to be accorded the lion's share of the work involved in running the accelerated expresses from Euston to Manchester and Liverpool, and *vice versâ*. The enlarged boiler and water-bottom firebox of the latest type are unquestionable improvements, but both classes are apparently giving excellent results. Some of the accelerated trains are exceedingly heavy. The 5.30 p.m. from Euston to Manchester and Liverpool is one of the heaviest trains in the Kingdom, almost invariably weighing some 350 tons behind the tender, that is to say, exclusive of the engine and tender; perhaps we should say "engines" and "tenders," for under instructions from the Traffic Department trains of that weight are always hauled by two engines, although one four-cylinder compound has, when tried, proved quite equal to the test.

Small Amount of Loco. Compounding in Britain.

It is curious, in view of the widespread adoption outside Britain of the compound principle as applied to locomotives, that it has hitherto made so little way in the United Kingdom. Except for some sporadic experiments still in progress on the Midland and North-Eastern Railways with three-cylinder compounds, and on the Lancashire and Yorkshire with one of the four-cylinder type, Mr. Webb remains the only British locomotive engineer who builds compound engines. Yet he does so in the case alike of express and of heavy goods locomotives, and, apparently, with favourable results. It is one of the many anomalies attaching to this phase of locomotive practice that, whereas Mr. Webb has steadily increased the diameter of his two high-pressure cylinders until now it is no less than 16 in., M. de Glehn, whose four-cylinder compound system is the standard on every main line in France, and on some Swiss and German lines as well, persists in keeping down his high-pressure cylinder diameters below 14 in., and when desirous of enhanced power, seeks it in enlargement of his low-pressure cylinders; while Mr. J. Riekie, of the Indian railways, of whose three-cylinder compounds more should yet be heard, employs high-pressure cylinders just as large as if the engines were one of the simple-expansion type, using the one large high-pressure cylinder rather as an auxiliary resource. Mr. Webb employs 16-in. cylinders with 20½-in. low pressure: M. de Glehn employs 13¾-in. high pressure with 22-in. low pressure.

Proportion of h.p. and l.p. Cylinders.

As a matter of fact, the question of the proper proportionate relations between the respective areas of high-pressure and low-pressure cylinders is still an open one in the case of locomotives. But all questions as to the advantages of locomotive compounding, provided a satisfactory system be adopted, would appear to have passed much beyond that stage.

A New French Tank Engine.

On the French Northern Railway M. du Bousquet has just brought out a new compound tank engine for suburban traffic. It is on the tandem principle, arranged on a plan which was invented by himself, and which would probably have been applied to the express engines of that line but for the remarkable success which attended the De Glehn system. The new tank engines have outside cylinders placed tandem fashion, one considerably in advance of the other. There are six-coupled driving wheels, and the leading end of the engine is carried on a four-wheeled bogie. This locomotive is still in its experimental stage, but appears to promise extremely well.

More "Atlantic" Type Engines on Chemin de Fer du Nord.

Another of the splendid ten-wheeled express engines of the "Atlantic" type shown in the Paris Exhibition of 1900 has just been delivered to the same railway by the Société Alsaciene de Constructions Mecaniques, of Belfort and Mulhausen, of which M. de Glehn, the inventor of the system of compounding known by his name, is general manager. This engine (No. 2·660) completes the first batch of twenty ordered. The series is numbered 2·641 to 2·660, the first figure representing simply the class as indicated by the number of axles coupled. The Nord "Atlantic" engines, while compounded on M. de Glehn's principle, which has proved so valuable, are in all other respects specially designed by M. du Bousquet, the able chief mechanical engineer of the Chemin de Fer du Nord, and are suited with singular and admirable exactness to the duty for which they are designed—viz., the fastest and heaviest express work in Europe, not excepting Britain.

Their Splendid Work.

With 2,275 square feet of heating surface, 228 lbs. per square inch of steam pressure, two 13½ in. high-pressure cylinders placed outside, two 22 in. low-pressure cylinders placed inside, 25¼ in. piston stroke in each case, four 6 ft. 8 in. driving wheels coupled, and nearly thirty-four tons of adhesion weight, these fine locomotives have proved capable of hauling trains weighing 360 English tons behind the tender at average speeds of sixty miles an hour and upward on a road of the same average difficulty in respect to gradients as the English Great Northern between King's Cross and Doncaster, or the Midland between St. Pancras and Bedford—a much harder road than the London and North-Western between Euston and Crewe. They are used on the accelerated trains recently put on by the Chemin de Fer du Nord, which include seventeen start to stop runs booked at average speeds of fifty-five miles an hour and upward. As these trains usually have a minimum weight of 200 English tons behind the tender, and often load up to 250, 275, and 300 tons and even more, while they maintain admirable punctuality, no better testimony is needed to show the efficiency of M. du Bousquet's engines.

BUSINESS SYSTEM & ORGANISATION.

BY

D. N. DUNLOP.

In this article a simple system of cost-keeping is given in outline. This is intended to serve as a foundation, which the manager of a firm can elaborate to suit his own requirements.—Ed.

II.

THE main factors of industrial success (as stated in the general article in our last issue) are excellence in workmanship, economy in production, increased output, and a right appreciation of the practice of scrapping, the whole dominated by a spirit of enterprise, tempered by experience and realised by means of an intelligent and well-thought-out organisation.

The initial step in securing this thoroughly efficient organisation is to institute a complete system of record-keeping throughout the establishment by means of cards which, as we have already seen, afford endless facilities that lie quite outside the possibilities of ledgers and bound sheets of any kind.

The principles of the organisation of factories, workshops, etc., and the various methods of cost and record-keeping are taught in most of the American technical colleges, whereas in Great Britain the subject has received but little attention, and manufacturers who have adopted or evolved a system working successfully are very jealous of revealing their methods. This policy of reticence is a mistake, for the advantages of comparison are uncontrovertible and trade secrets need never thereby be revealed.

ADVANTAGES OF ACCURATE COST-KEEPING.

The manufacturer will readily understand the immense power and advantage to be derived in these days of keen competition from an accurate and easily accessible knowledge of his costs in every department. There is no information placed before the manufacturer that is more important than an accurate computation of the cost of manufacturing each separate article which he sends forth into the markets of the world. Only by means of this information can he safely quote a sale price that will at the same time secure a brisk business and a sure and fixed profit.

A perfect system of cost records carried out to the letter is the only absolutely safe guide in tendering for contracts. To secure a profitable contract, a manufacturer whose goods have a reputation for excellence must draw up his tender on an absolute basis of accurate facts and figures brought up to date, and not on hypothesis or even approximate figures.

The manufacturer of a standard line of goods is often tempted to be guided in fixing his selling prices by those of his competitors—a dangerous method of working in the dark which amounts to nothing short of speculation.

A system of factory records should be made with the following aims kept in view: (1) To lessen the cost of production; (2) to estimate the cost of products collectively and in detail; (3) to fix the sale price of the article on a safe basis.

A SIMPLE COST SYSTEM.

A simple cost system would be welcomed by the majority of managers who have, until now, done without it, as a means of combating the keen competition which is steadily on the increase. Although excellent systems, both simple and complex, have become general in the United States, where they work smoothly, the change is not easy to effect in England on account of the difference in the labour conditions, and of the difficulty in overcoming the workmen's antipathy for pen or pencil and his reluctance to adopt any innovation.

The following simple system given in outline is intended to serve as a foundation, which the manager of the firm will elaborate so as to suit his own requirements, or from which he may derive some suggestion beneficial to the organisation of his establishment.

A record must be kept of all operations performed throughout the establishment, whether productive or non-productive. A modern factory resembles a small city, and many trades are represented within its walls. Its scope comprises general administration, superintendence, office clerks, mechanical engineers, draughtsmen, designers, gauge-makers, tool-makers, machinists, foremen, watchmen, carpenters, oilers, belters, electricians, packers, shipping clerks, labourers, sweepers, etc., all of these being non-producers classed in groups of overhead expenses, which must be pro-rated on the producing departments.

Factory costs do not indicate profit, but form a concise statement of what the factory is doing. The main items of cost are material, labour, manufacturing supplies, special items of cost, and general expense.

DESCRIPTION OF SYSTEM.

Production orders may originate from—

(1) A specific shipping order or contract.

(2) Depletion of machine or detail, the shortage being reported by the stores-clerk as soon as the stock sinks to the fixed minimum.

(3) Plant—orders which cover all work in the nature of repairs or improvements to the plant or building; any work, in fact, which will become an addition to the plant or an expense-charge to the business.

On receipt of an order from a customer, or of the acceptance of a tender, the manager takes the initial step in production by authorising each department of the factory to set to work. All firms have their own methods of dealing with orders. The usual plan of keeping an order-book is being superseded by a cabinet of order cards, each order being entered as received, numbered and marked with necessary references to estimate, tender, and letter, and probably also to the customer cabinet.

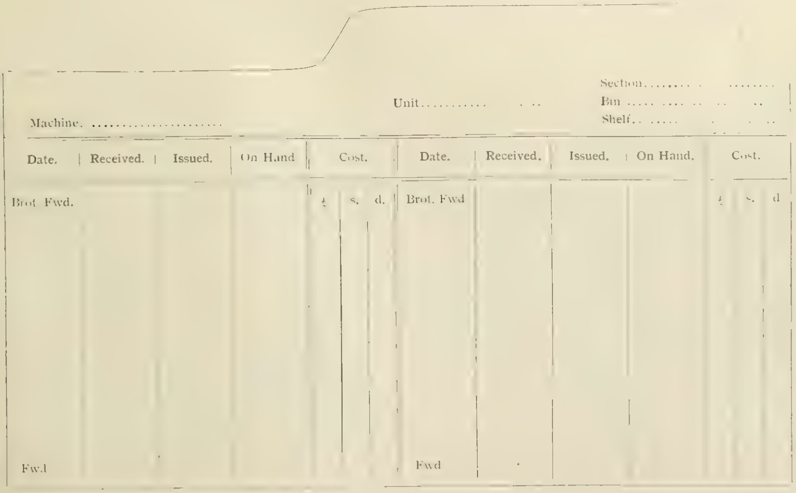
The order cabinet is accessible only to the manager and his clerk. The first step is to give instructions to the drawing-office in writing, either by letter or card, or by sending for the drawing-office order-book and making the required entry. It is in this department that the drawings are made or collected for the forthcoming work and the working lists prepared, providing full instructions for all foremen and officials concerned in the manufacture of the article down to the smallest detail. The working list is, in fact, a specification of everything required for the order, and from this list the superintendent or the manager makes out all production orders separately to each department; a duplicate copy being retained and filed by the production order-clerk.

Some managers send a duplicate of the working list in full to the stores-keeper and to each foreman, and, in addition, general and special instruction sheets containing every detail and the time in which it must be completed.

THE STORES-KEEPER.

The stores-keeper has charge of the material, and by the use of the card-system, the exact amount of material received, issued, and the balance on hand, with the cost of the same, can be ascertained at any moment. The material-cards, therefore, and the machine schedule together form a record of all material from its entrance into the factory till its exit as a finished product.

Two separate sets of cards are required: one for the stock-keeper for requisitions of material addressed to the manager or superintendent to replenish his stores, and another for material issued to the various departments of the factory. The material requisition-card bears on a tab the name of the material or article; the space below is ruled horizontally for entering the section in which it is kept, and the bin number, the unit of measurement or the part of machine, and the shelf number; the rest of the space is ruled in vertical columns for *date received*, *issued*, *on hand*, *cost*, both sides of the card being alike.



Machine. ....

Unit........... . ..

Section......... . ...

Bin ....

Shelf.. ....

Date.	Received.	Issued.	On Hand	Cost.			Date.	Received.	Issued.	On Hand.	Cost.		
Brot Fwd.				£	s.	d.	Brot. Fwd				£	s.	d
Fwd.							Fwd						

The "material issued card" bears on the tab the order number, and below, in horizontal spaces, the date, the foreman's punch or signature, for what part of machine or product it is wanted, and the department to which it is issued; the rest of the card is divided into columns for *quantity*, *material*, and *price*. This card contains all the material required by the foreman for the work of his department in the order, and the stock-keeper, after checking the card and issuing the material, tranfers the separate materials from the foreman's card on to corresponding material cards and makes his balance, afterwards forwarding the two cards to the stores ledger-clerk, who registers both in his ledger (which should also consist entirely of cards in a cabinet), and returns them to their departments.

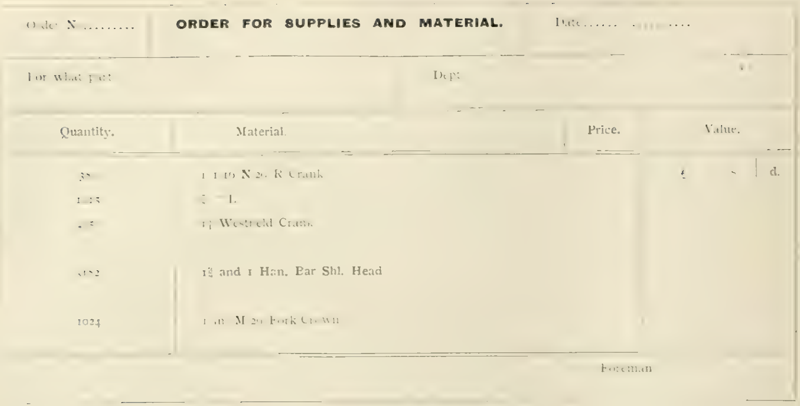
THE THREE KINDS OF LABOUR.

Labour in manufacturing is divided into three classes: (1) Productive labour, which converts raw material into a finished product; (2) department non-productive labour, essential to productive labour, but not producing anything itself, such as that of foremen, clerks, sweepers, oilers, etc., etc.; (3) general non-productive labour, necessary for the operation of the producing department, such as shipping department, stock-room, timekeeper, engineer, etc. All three kinds of labour must be reckoned in the costs, the result corresponding to the payroll for the period considered.

In order to handle labour profitably in connection with this system, piece-work prices should be established in all departments, for this simplifies records, reduces the clerical payroll, and effects a saving in the cost of manufacture; piece-workers usually producing more work in a given time than day-workers. In that case, each of the manufacturing departments would be provided with a small card cabinet in which the record of the piece prices for the department is kept.

MECHANICAL TIME RECORDERS.

Each factory has some system of record keeping for the time of each man's arrival and



Order No. .... **ORDER FOR SUPPLIES AND MATERIAL.** Date........

For what part Dept

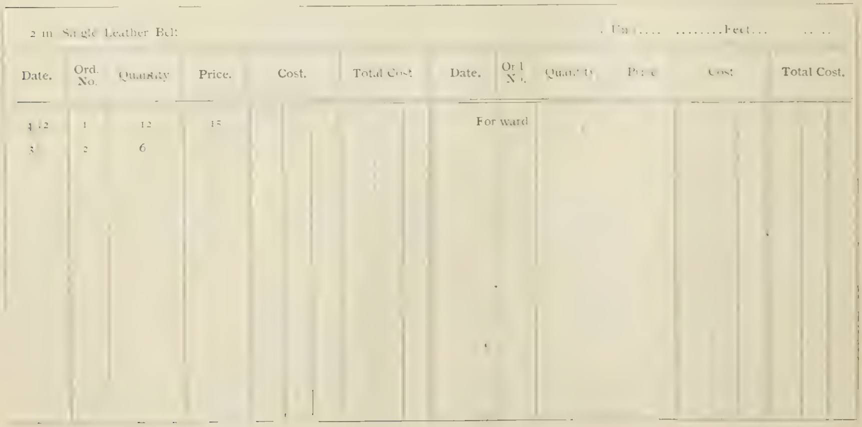
Quantity.	Material.	Price.	Value.
			£ s. d.
[illegible]	[illegible] R Crank		
[illegible]	[illegible] L.		
[illegible]	1¼ Westfield Crank		
[illegible]	1⅝ and 1 Han. Bar Shl. Head		
1024	[illegible] M 20 Fork Crown		

Foreman

departure from the works. Time boards and check systems are mostly in vogue in England, but they will, in time, probably give place to the use of a mechanical recorder. This is a clock that prints the time of arrival and departure on a card. All the men have to do on receiving their card from the timekeeper is to drop it into a slot, press the lever, take out the card, and hand it to the timekeeper, who uses it to make up his pay-roll.

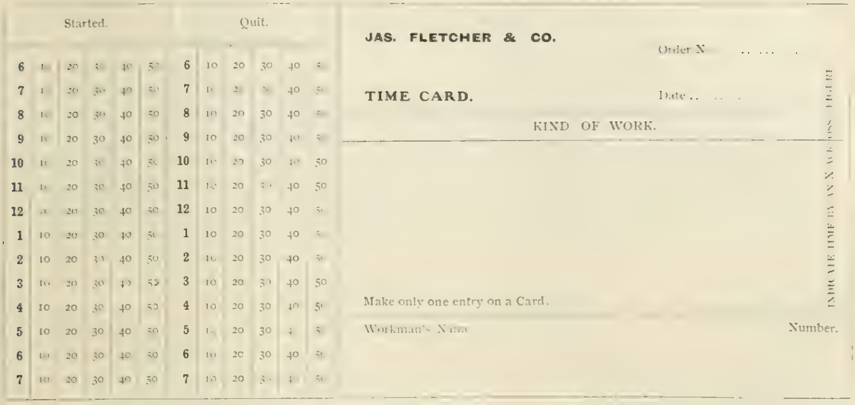
The foreman now being in possession of his instructions and material proceeds with the work. He assigns to each workman his job, giving him a time-card on which every item but the time is filled up. The tab bears the order number, and the card is spaced for entering the date, a description of the work to be done, the workman's name and number, and time columns *started* or *stopped* or *quit* by tens of minutes from opening till closing time.

One job only is recorded on each card, the workman making a cross over the time when he begins and finishes it. These cards are handed to the foreman for his O.K. punch, and he sends them to the cost-clerk,



2 in. Single Leather Belt. Unit........ ....Feet...

Date.	Ord. No.	Quantity	Price.	Cost.	Total Cost	Date.	Ord. No.	Quantity	Price	Cost	Total Cost.
4/12	1	12	15			Forward					
3	2	6									



Started.						Quit.					
6	10	20	30	40	50	**6**	10	20	30	40	50
7	10	20	30	40	50	**7**	10	20	30	40	50
8	10	20	30	40	50	**8**	10	20	30	40	50
9	10	20	30	40	50	**9**	10	20	30	40	50
10	10	20	30	40	50	**10**	10	20	30	40	50
11	10	20	30	40	50	**11**	10	20	30	40	50
12	10	20	30	40	50	**12**	10	20	30	40	50
1	10	20	30	40	50	**1**	10	20	30	40	50
2	10	20	30	40	50	**2**	10	20	30	40	50
3	10	20	30	40	50	**3**	10	20	30	40	50
4	10	20	30	40	50	**4**	10	20	30	40	50
5	10	20	30	40	50	**5**	10	20	30	40	50
6	10	20	30	40	50	**6**	10	20	30	40	50
7	10	20	30	40	50	**7**	10	20	30	40	50

JAS. FLETCHER & CO.

Order No. ....

TIME CARD.

Date .. .. ..

KIND OF WORK.

Make only one entry on a Card.

Workman's Name

Number.

INDICATE TIME BY AN X ACROSS THESE

who registers each and distributes the facts on their various ledger cards, figuring out the productive labour, and adding this to the material figures received from the stores department. This done, he hands over all the time-cards to the timekeeper, who checks the total labour per man by the arrival and departure record-cards from which the pay-roll is made out.

RELUCTANCE OF BRITISH WORKMAN TO ENGAGE IN CLERICAL WORK.

Bearing in mind the extreme reluctance of the British workman to engage in clerical work of any kind, with the consequence that many minutes are wasted and that he puts off his entry till the last minute and often forgets it altogether, a system which does away entirely with all use of the pencil is to be recommended. The mechanical time recorder can again here be used to advantage. The workman, on receiving his job card (which need only have two spaces left for the time entries) from the foreman, puts it into the slot, presses the lever, and withdraws the card, on which the exact time will be found printed under "start"; he hangs the card up before him until the job is finished; goes through the same performance with the recorder, takes his card to the foreman to be examined and punched; and receives another for the next job.

THE MANUFACTURING EXPENSE.

The manufacturing expense comprises the supplies used for the factory, such as belting, emery cloth, sand paper, emery wheels, grindstones, files, twist drills, wood bits, planes, knives, buckets, brooms, maps, stationery, fuel, etc., which should be given out from the storesroom on card requisition from the department to which it is charged at proper value.

A two-drawer cabinet will suffice for supplies in the storeroom of a medium factory. It is best to sort the cards by using guide cards for the name of the supply article, the department number being entered on the tab of the card. The faces of the card contain the supply article and unit as heading, with columns ruled for date, order number, quantity, price, cost and total cost—this for keeping the cost-total up to date. The manufacturing expense is then prorated over the cost of machines and the same is done with the general expenses, which include all expenses not connected specially with any one department of the factory, such as power, general lighting and heating, salaries of the staff, etc.

THE STAFF REQUIRED.

The manager's cost-clerk acts as paymaster, and the production-order-clerk is also purchasing-clerk. The stores-ledger-clerk is responsible for all records of material until they are turned over to the cost-clerk.

The acting manager needs a stenographer, a filing clerk, a book-keeper (the accounts are all kept on the card system), and an order clerk, who handles the shipping orders and is assistant book-keeper.

WORKSHOP PRACTICE

A RÉSUMÉ OF MACHINE TOOLS, CRANES, AND FOUNDRY MATTERS FOR THE MONTH.

CRANES.

ABOUT four or five years ago auxiliary hoists were first fitted to electric overhead travelling cranes. These are hoists of lower power than the main gears on the crab, and their introduction was due to the growth of the separate motor system. The auxiliary hoist is fitted with its own motor, and it is operated more rapidly than the main one, in order to handle the lighter loads which form so large a proportion of the total number lifted in most shops. A recent installation of cranes at the new foundry of the Pennsylvania Steel Co. contains three 20 ton overhead travellers, each with its 10 ton auxiliary hoist; two of 50 tons each provided with auxiliary hoists of 25 tons power, and one of 25 tons with a 15 ton auxiliary.

The demands made upon cranemakers have been far more exacting since the introduction of the electric drive than they were formerly. What was good enough for a hand, or even a steam crane, is not up to the mark for the high speeds of motor driving. The difference is largely that between getting up speed and reducing it. Speed reductions are not so great as they were in the first half dozen years of the new departure, when high-speed motors were the rule, but they are still necessarily large. Thus, in a recent 75 ton overhead travelling crane by Messrs. Joseph Adamson and Co., the reduction from the main hoisting motor to the worm wheel is 19 to 1, and two other reductions of 4 to 1 and 6 to 1 respectively take place thence to the hoisting barrel, through double helical wheels with shrouded teeth. No roughly made gears would endure the duty thus imposed. In this particular instance the worm is of nickel steel, treble threaded; its shaft is fitted with thrust collars, lubricated automatically, and the rim of the worm wheel is of bronze bolted on a cast iron centre.

The cutting of worm's of such steep pitches, running at the high speeds of their driving motors, has rendered greater care than ever necessary to ensure the correct tooth shapes, which can only be obtained by machine-cutting, effected in most cases by hobbing, and by employment of the oil bath to effect proper lubrication. But the gain has been correspondingly great, for the worm gears, not long since nearly abandoned in crane work, are now used more than at any previous period. There is no method so satisfactory for rapid reduction of speed as the double or treble-threaded worm gear. In the tests of the Adamson crane, the worm gear showed an efficiency as high as 53 per cent. at two-thirds full load, and we believe that this is not the highest obtained in the experience of this firm. The crane is also interesting because the load is lifted by a sprocket chain, hauled around a sprocket wheel, instead of around a drum, the slack chain being received in a pocket beneath. This practice is one which is commonly employed by Continental crane builders.

FOUNDRY MATTERS.

A new brass-melting furnace, the Schwartz, which is being tried in America, is designed to melt metal without crucibles. It bears considerable resemblance to the Bessemer convertor in shape, and in being tilted on trunnions by worm gear for lining it. Air and oil pipes enter through one of the trunnions. Crude petroleum is the fuel used, forced from a tank containing sixty gallons through a $\frac{3}{4}$ in. pipe under an air pressure of 40 lbs. The blast is supplied by a small pressure blower. The metal is charged through the top, which is then closed with a cover. The furnace is heated before charging, and from 400 to 500 lbs. are melted in an hour. The metal is then emptied into ladles and poured like cast iron. It does appear probable that the constant attacks which are made on the old air crucible furnaces must in time cause their disappearance. But brass founders are most conservative of those rudely designed furnaces, easily built, easily worked, and readily repaired, and fairly economical. Then the reverberatory furnaces are excellent for dealing with large quantities of metal without crucibles, and the writer can call to mind a case in which, failing this, a big melting was made at a push in an ironfounder's cupola.

A combination of American steel foundries is in progress. The firms involved control about 25 per cent. of the output of steel castings in the United States. The organised capital will be 40,000,000 dols., and the name proposed for the new company is the "American Steel Founders."

MACHINE TOOLS.

Another vertical turret lathe has been recently put on the market by Mr. W. H. Foster, of New York. The best-known lathes at present with vertical turrets are the Pittler and the Wolseley, the turret lying at right angles across the top of the bed in the first case, and being arranged parallel with it in the second. The Foster turret encircles the bed, and affords some good points in design, among which we note its fitting in an annular seating, which is double veed in section, with provision for taking up wear, and its variable rate of revolution, starting slowly to maximum speed, then decreasing and coming to rest as the locking bolt is slid into place. It carries eight tools. The spindle takes stock $2\frac{1}{2}$ in. diameter.

The battle of the feeds still goes on. The present evident tendency is towards wider applications of positive feeds by toothed gearing. One reason is, of course, that machine tools are more than ever wanted to be driven up to their fullest capacity, without slipping under the hardest duty. Another is the desire to do away with belt shifting, and to substitute the movement of a lever or levers, without checking or stopping the movement of the machine.

Another matter which one is being reminded of constantly is the growing practice of giving a regular gradation of speeds and feeds to machines. In the older practice little regard was paid to this, but a fairly regular gradation was given with, say, the stepped cones alone, and then a big gap was left between these and the back geared speeds, which again were not in regular order. Apparently, we shall arrive at last at an earnest rivalry between this regular gradation in steps, and the continuous and infinite changes obtained by the bowl and disc, and by the reverse cones of the Evans type. It is difficult to say whether for really practical results one is preferable to the other. Personal predilection counts for much in settling questions of this kind.

We wonder whether the new draw stroke shapers will ever become formidable rivals to the older pushing stroke type. Baker Bros., of Toledo, Ohio, are making them as a direct application of the operating mechanism of their well-known key-seating machines to the wider sphere of shaping. The pull of the cut comes downwards on the face of the work bolted to a bed, so that heavier cutting can be done than when work is carried on a knee, and the tool is thrust along. Heavy tooling is one of the essentials in modern production, and radical changes in methods are in progress having this object in view. It is not unlikely that the designs of some of our machine tools will be modified in the direction named above, for a draw cut is the least likely to chatter under heavy duty. From this point of view alone it would be better if the tool-box of a planer were set on the back of the cross rail instead of on the front.

THE REORGANISATION OF OLD WORKS.

The building of new works, and the rebuilding and reorganisation or extension of old works, goes on apace. The new contrasts strongly with the old in so many ways that the next generation will wonder how competitive production ever went on profitably under the old conditions. The old shops were dark, dirty, ill arranged; with stories and stairs, cold, lacking in conveniences and comfort for the hands, just as though it would be a serious blunder to make them warm and at their ease. On the other hand, discipline is tighter now than ever, and men are confined more strictly to their own departments and to their little sectional duties. Machines are sorted out and arranged in groups, and the duties of attendants leave little scope for initiative. We are clearly at the threshold of a new era in industrial organisation, the era of big aggregations of capital in factories, arranged for the intensest competition, in which the altruistic arrangements for the workpeople form an economical asset. The next stage may possibly be the general linking of the interest of the workers with that of their firms in a system of profit-sharing and of pensions. In any case it is certain that the time of the little higgledy-piggledy works, and of the unattached tramp, is passing away.

COMPETITION OF GERMAN MACHINE TOOL MAKERS.

The competition of German machine tools may be expected to hit the British manufacturer as hardly as that of the American tools has already done. Germany, which formerly imported much from America, now takes less. In the year 1901 these imports were 1,166 tons, against 4,757 tons in the year previous. In the first quarter of 1902 they were but 107 tons, against 399 for the first quarter of 1901, and of 1,501 tons for the first quarter of 1900. But for the heavy United States tariff on imported machines the Germans would soon be able to send their goods into America. She will, doubtless, make a supreme effort soon to elbow British tools out of British shops, as she has already done in small goods, and tapped much of our foreign trade.

ARE SYSTEMS OF COST-KEEPING BEING OVERDONE?

It is questionable whether in the elaboration of systems of cost-keeping one vitally important item is not overlooked. System is essential, and some reasonable amount of red-tapeism; but behind it all there must be a most intimate knowledge of workshop practice. It is not enough to know that so much labour has been expended in the production of a piece of work. It is more necessary to know how much labour ought to have been put into it, whether time has not been wasted, and whether there may not be a shorter cut to the same results. A cost clerk is helpless without the co-operation of the responsible man in charge, who alone can exercise a salutary check upon the labour costs.

Another point is that the system which is well adapted to one establishment is not suitable for all others. Firms would do better by studying the requirements of their own works than in attempting to model them after other shops. In many small establishments there is no need of any system beyond a proper supervision over all details. When cost-keeping and technical education have been utilised to their extremest limit yet contemplated, the man of long experience will still hold the cards by which money-making is accomplished.

DEVELOPMENTS IN CYANIDE PRACTICE.

BY

EDGAR SMART, A.M.I.C.E.

II.

ANOTHER characteristic feature of recent date on the Rand goldfields is the systematic and profitable treatment of slimes direct from the mill, which is carried out in the following manner: Lime is added to the outflow from the second sand vats in the classification plants already described, in order to coagulate the slimes and to assist their settlement. This it does so effectually that a single large spitzkasten is sufficient to so completely eliminate the slimes that the water is clear enough to be immediately returned to the battery for further use. After a time, of course, the whole of the battery water becomes alkaline, so that the quantity of lime added per ton of slime thrown down is only a few pounds' weight. The slime separated by the spitzkasten is still mixed with a considerable quantity of water, and it is delivered to a vat, in which it is allowed to settle, after which the clear water is decanted off. The settled slime remaining in the vat after this decantation generally contains about 50 per cent. of moisture, or, in other words, the weight of actual slime is equal to the weight of water mixed with it. The vat is provided with means for agitating its contents—sometimes a vertical shaft with revolving arms, and sometimes a centrifugal pump which sucks from near the bottom of the vat, and delivers to the top of it. When the settled slime is ready for treatment, cyanide solution is added until the whole quantity of liquid present is equal to about $3\frac{1}{2}$ tons for each ton of dry slime. The mixture is then agitated to bring every particle of slime into effective and prolonged contact with the cyanide solution in order to cause the dissolution of the gold. When this is found to be sufficiently completed the contents of the vat are allowed to settle, and the clear, gold-bearing cyanide solution is decanted off. Again, the settled slime retains an equal weight of liquid, consequently the amount decanted is $2\frac{1}{2}$ tons per ton of slime. And therefore a simple proportion sum will give the percentage of the total dissolved gold which is drawn off with this first cyanide decantation, thus :—

$3\frac{1}{2} : 2\frac{1}{2} : 100 : 71{\cdot}43$ per cent.

A weaker cyanide solution or wash water is then added until the quantity of liquor is once more made up to $3\frac{1}{2}$ tons per ton of slime. The mixture is then agitated again, but only for a much shorter period than at first, because the object of the second agitation is merely to mix the fresh liquid intimately with the gold-bearing solution left behind by the first decantation. And as this contained the remainder of the dissolved gold—*i.e.*, 28·57 per cent.—it is obvious that a second settlement and decantation will bring out 71·43 per cent. of this amount, that is to say, 20·41 per cent. So that after the second decantation 91·84 per cent. of the dissolved gold has been withdrawn from the slimes. Now, assuming that of the total gold originally present in the slime only 90 per cent. was dissolved, it will be seen that the gross theoretical extraction at the first stage is 64·29, and at this second stage is nearly 83 per cent. If a higher rate is desired more water is added, and the agitation, settlement, and decantation are repeated. This third series of operations will bring the total theoretical extraction up to 88 per cent. The proportion of this, which is actually recovered as smelted gold, will depend, of course, upon the efficiency of the method of precipitation adopted and upon the care with which the precipitates are handled. By the use of more water and a repetition of the above operations still higher results can, of course, be attained, but a very serious practical objection exists in the difficulty and cost of precipitating the gold from such large quantities of low-grade solution. The cost of precipitation per ton of solution passed through the boxes is practically the same, whether it carries much or little gold, but it is difficult to get any gold at all from very poor solutions, and this difficulty, together with the cost of prolonged treatment, limits the practical efficiency of the process to the figures given above. By carefully ascertaining the cost of precipitation, and also the cost of applying each wash to the slime, including, of course, the agitation and decantation, it is possible to determine very accurately the practical limit of economical extraction in each particular case.

It may be remarked here that among the developments of the cyanide process may be reckoned the practice of keeping accurate and *detailed* accounts of the current expenditure. This is certainly not an entirely new feature in metallurgical operations, but the working of low-grade material on an enormous scale has brought into prominence the absolute necessity for such accounts. So long as rich material is being treated almost any kind of management results in a profit, and so long as the treatment shows a profit directors are very liable to be satisfied with the management, with the result that detailed accounts are not called for. And again, in a small plant where the output is perhaps only 1,000 tons per month, the possible saving of 1d. per ton, or £4 3s. 4d. monthly, does not appeal to the directors and manager in such a forcible manner as the same prospective penny does when the output is 20,000 tons per month. And on the large works the said penny is not to be saved by the crude expedients of cutting down wages or restricting supplies of necessary material which are so often tried on small undertakings. The gain is to be made by having good labour well organised, good material systematically supplied, but above all by careful analysis of the detailed accounts in order to find out what degree of technical perfection in the process employed will give the maximum net profits. And this is indeed the most important use and object of such accounts.

SLIME TREATMENT WITH FILTER PRESSES.

A method of separating the gold-bearing solution from treated slimes by the use of filter presses was originally introduced in Johannesburg by W. Bettel, but was only tried in a small way because the value of the slimes in that district did not appear to justify the expense. But it has been recently adopted with success for rich material on the West Australian goldfields. In many cases the ore is ground so fine in Wheeler pans for the purpose of amalgamation that the whole of it can be treated as slime in agitation vats at the cyanide works. After agitation with cyanide solution in the manner already described in the preceding section the slimes are run into a steel receiver, and thence are forced by compressed air with the solution into filter presses usually of the well-known Dehne type. The solution comes through the filter almost clear, and the slime forms into cakes in the press containing only about 20 per cent. of moisture. In order to wash out part of the remaining solution, water is passed through the cakes in the press, and at one time it was considered probable that this wash water might pass through cracks or channels in the cakes, and that the washing might therefore be imperfectly carried out. Had this difficulty existed it could have been overcome by agitating the material from the press a second time and repressing it. But in practice it is found that the washing in the press is satisfactory, and at the present the whole cyanide treatment is given in the press at some works. In order to compare the advantages offered by this process with those of the decantation method, take again the case of one ton of dry slime mixed with three and a half tons of solution in the agitation vat. Only a quarter of a ton of solution will remain in the cakes in the press, so that the dissolved gold brought out in the solution will be as follows:—

3·5 : 3·25 : : 100 : 92·85 per cent.,

or assuming as before that 90 per cent. of the total gold is dissolved, the gross theoretical extraction is 83½ per cent. as against 64·29 per cent. after the first solution in the decantation process. A second agitation and press filtration, if such were necessary, would show a theoretical extraction of 89·58 per cent. against 82·65 per cent. by the other method. But by washing in the press this higher extraction can be obtained probably with much less water than by a second agitation. It follows, therefore, in spite of the objections that may be urged against this method, that for very rich material the filter-press treatment is undoubtedly better than the other. At present there are not sufficient data as to the cost of the West Australian work to calculate even approximately the limiting value which would justify the use of filter presses. It would be somewhere near the mark probably to say that when 10 dwt. material is to be treated a careful comparison of the costs of the two methods under local conditions as to price of labour and materials should be made before deciding upon either method. It must not be forgotten, however, that while the use of filter presses is still comparatively in the experimental stage except as regards West Australian ores, the decantation process has been practically proved by the treatment of many hundred thousand tons of slime and on several classes of material. And a safe motto for engineers is, "When in doubt adopt the proved process." It being understood, of course, that it is honest doubt which, after careful investigation, may be due to the want of reliable data, and not the doubt of the lazy man who will not take the trouble to compare processes, even when facts and figures relating to both are readily available.

DIRECT TREATMENT OF ORE—DRY CRUSHING.

The methods of application hitherto described have referred exclusively to the treatment of material that has previously undergone amalgamation, but there are many cases in which the cyanide process alone is used for the treatment of ore direct from the mine. This, of course, can only be done when the whole of the gold in the ore is in a very finely divided condition. This is the case in the Hauraki district of New Zealand, where direct treatment has consequently been applied on a very large scale. The ore is a tough, hard, quartz, and in cases where dry crushing has been adopted it was sufficiently wet as it comes from the mine to require drying before crushing. This was formerly sometimes done by burning in a kiln excavated in the ground, with a tunnel below and an outlet at the bottom of the kiln for discharging the dried ore. Otherwise the drying is carried out in a furnace with a steeply inclined flue having cast-iron shelves so arranged that the products of combustion can pass around and through the ore on the shelves. An ordinary stamp mill is used for the dry crushing, and from the battery screens the ore falls into conveyors which carry it to bins, whence it is withdrawn as required and trucked to the treatment vats. The results are satisfactory as regards the extraction obtained, which amounts to about 92 per cent. of the value in the ore. But there are several disadvantages inherent in this method, for the battery crushing dry gives only from half to three-quarters of the output of a similar mill when wet crushing the same class of ore. Then, again, the amount of dust pervading the whole of the mill is not only disagreeable, but affects the workmen very seriously. Also the extra pounding (as evidenced by the lessened output) which the ore undergoes before it can escape through the screens, leads to a large proportion of very fine stuff in the product—a fact which, as already discussed at length, is detrimental during the subsequent leaching. Consequently, it is found necessary in practice to limit the depth of material in the treatment vats to 2 ft. 6in. or thereabouts. It must also be noted that the ore of this district is specially suitable for this treatment, because it contains only a small amount of mineral matter. With ore containing a large quantity of pyrites, the preliminary drying of the ore is very liable to result in the partial decomposition of the pyrites, with a corresponding loss of cyanide in the after treatment.

Therefore, in America, with heavily mineralised ores, dry crushing, even when preceded by drying, is followed by complete roasting, and carried out in this way it forms a very important feature in American practice. The general sequence of operations may be summarised as follows: First the ore passes over grizzlies to Gates rotary breakers with trommels to size the stuff and elevators to return the coarser pieces to the breakers after each screening. Then the broken ore passes through a set of coarse crushing rolls, provided also with sizing trommels and elevators to return the rejected material; then through a set of fine crushing rolls similarly equipped, and the final product from the fine rolls goes to storage bins. After this the ore is roasted in mechanically operated furnaces, and is then ready for cyaniding in the usual manner. Generally speaking, the roasting of the material may be expected to improve its leaching qualities by destroying the plasticity of its clayey portions. When coarse gold is present the residues from the cyanide vats are sluiced out over amalgamated plates. In this way certain classes of ore are now treated for which a few years ago the chlorination process would have been recommended without hesitation, and there appears to be a great probability that in the near future there will be a large and constantly extending field in this direction for the application of the newer process.

Another modified form of dry crushing and cyaniding remains to be mentioned. In several mines in the Transvaal, especially in the up-country districts, a class of ore has been met with from which the gold can be leached out when it is only very coarsely crushed without reducing it to fine sand. In such cases rock breakers and one set of rolls are sufficient to reduce the ore to the size of peas. When the ore is sufficiently dry to be crushed to this size without preliminary drying, all the conditions lend themselves to very economical work. But such a method is obviously not capable of general application, but is limited to those cases where either the gold is mostly in the cleavages of the stone, so that it becomes exposed on the surfaces of the broken pieces, or else when the ore is such a porous nature that the cyanide solution can not only penetrate into it, but can also be drained and washed out of it again. This latter condition is found sometimes in the upper weathered and oxydised portions of reefs, which are quite solid and impervious at lower levels of the mine, and hence it may be expected that at places where the method now gives excellent results, at some future date one or other of the more usual systems will have to be adopted.

CRUSHING WITH CYANIDE SOLUTION.

Owing to the objections already mentioned to the method of dry crushing and cyaniding used in New Zealand, John McConnell has introduced a modified form of wet crushing in which cyanide solution is supplied to the mortar boxes instead of water. The idea is not new, as it was tried unsuccessfully on the Rand many years ago, but it is in this case applied in a novel and successful manner. In this method the quantity of solution supplied to the battery is limited to about two tons per ton of ore crushed, thus forming a very thick pulp. Lime is also added in the mortar boxes to assist the clarification of the solution at a later stage of the operations. The pulp leaving the battery is run over amalgamated tables of the ordinary kind to catch any coarse gold that may be present, and is then delivered into collecting vats of the peripheral overflow type, wherein the greater part of the material is retained. The overflow from these collectors passes to slime settling vats, whence the solution passes away through the zinc precipitation boxes to storage vats, and so through the battery again in a continuous circulation. When one collecting vat is sufficiently full the stream of pulp is diverted to another collector, while the pulp collected in the first one is allowed to settle with the assistance of a little more lime which is added at this stage. The clear solution remaining above the top of the settled sand is drawn off from it, and the charge is then treated by vacuum leaching carried out in the manner previously described. This method, originally introduced at the Crown Mines at Karangahake, appears, if one may borrow an American expression, to have come to stay, but like other methods it is, of course, not universally applicable. For instance, it is obvious that for an ore which requires special alkaline or other treatment *before* contact with the cyanide solution this system is inadmissible. It may be noted that with the limited quantity of solution the output from the battery is not much in excess of the amount produced by dry crushing.

CHEMICAL CONSIDERATIONS.

Apart from methods of precipitation, which will be described later, the principal progress under this heading has been made in two directions. First by very much decreasing the strength of the cyanide solutions used, and secondly by paying greater attention to their oxygenation. A few years ago nobody ventured to use a solution containing less than 0·5 per cent. of potassium cyanide, but at the present time the maximum strength used is about 0·25 per cent. In treating sand in cases where electrical precipitation is employed, the strong solutions contain only 0·1 per cent., while for slime treatment, 0·01 per cent. is considered a strong solution, and the weak solutions go down to as little as 0·001 per cent. As regards the supply of oxygen to the solution, so long as the application of the process was limited to the treatment of battery tailings, especially those from which the sulphide minerals and the like had been previously eliminated by concentration, the quantity of oxygen contained in the successive solutions, reinforced by that which was present in the pores of the sand, was always sufficient for the dissolution of the gold, and no trouble was experienced on that score. But it has been found more recently, especially in treating old slimes, in which a great deal of finely divided and partially decomposed mineral matter is present, as well as some organic products from decayed vegetable matter, that these impurities absorb a large amount of oxygen, and sometimes all that is in the solution, and thereby greatly retard the solvent action of the cyanide on the gold. In most cases this difficulty can be overcome by the use of a greater quantity of wash-water, which carries practically as much oxygen as the cyanide solutions, but this will require either great capacity in the washing vat or else several separate agitations, and is therefore costly.

Several methods of mechanically supplying oxygen to solutions have been introduced from time to time. Perforated pipes are sometimes placed in the bottom of the vat, and compressed air is continuously supplied to the liquor through the very small perforations. The use of wide, shallow, open launders instead of pipes for the transfer of solutions is to be recommended. But probably the most satisfactory method is that proposed by H. T. Durant, who, when circulating solutions with a centrifugal pump, places a valve in the suction pipe whereby to check the supply of solution to the pump. Then between this main valve and the pump there is a small air inlet valve, which is opened sufficiently to allow the centrifugal to suck in a small but continuous supply of air, which is consequently churned up with the liquid by the revolving blades, and so is likely to be absorbed by the water, which has, therefore, an opportunity of saturating itself with air. It will be understood, of course, that this method is only applicable in the case of drowned pumps, because if the centrifugal were placed above the level of the tank from which the liquor is drawn this constant supply of air would quickly prevent the pump from sucking properly.

The use of chemical oxydising methods for cyanide solutions, which was originally introduced by H. F. Julian, has only been practically applied in a few isolated cases—partly perhaps owing to the existence of unexpired patent rights. The chief reason is that, as already mentioned, no special means of supplying oxygen is required for ordinary clean tailings, and Julian's methods were put forward at a time when these constituted the staple, and in fact almost the only material available for treatment by the cyanide process. Therefore, the use of oxydising agents was not required at that time, and it seems to have been lost sight of when the difficulties above referred to were encountered at a later date in the treatment of old slimes. With the familiar experiment of treating gold leaf in a beaker with oxydising agents, the effect is almost instantaneous. But in treating sands in practice the same agent has very little accelerating effect upon the rate of extraction of the gold. The reason is that in treating sand the actual rate at which the gold dissolves is not of great importance, because a lot of circulation is required to keep up a supply of active liquor in the neighbourhood of each particle of gold, and a large amount of liquor is necessary to wash out the gold when it is dissolved. So that in this case it is rather the rate of leaching than the rate of dissolving that is of supreme importance, and, moreover, the large volumes of solution used in the circulation and washing contain all the oxygen required.

But in the case of slimes which have to be mechanically agitated during the whole time required to dissolve the gold, any means for hastening the dissolution of the gold is important, and as the gold in this material is always in a very fine state of subdivision, there appears here to be a large field for the use of a cheap and effective oxydising agent. This is a matter which will doubtless receive attention when operations are resumed on the Johannesburg slime-plants, and the value of chemical oxidation of the solutions is determined by experiment on a large scale and under actual working conditions.

Progress has also been made in regard to the analysis of working solutions, and various methods of more or less practical utility have been devised by W. Bettel, A. James, J. E. Clennell, and A. W. Crosse, among a host of other workers in this direction.

PRECIPITATION BY ZINC.

In this department practically no alteration has taken place recently as regards the manner of bringing the solution in contact with the zinc shavings. For small plants treating comparatively clean sand or the like this means of precipitation is still used in the vast majority of cases in all parts of the world. Its great merit now, as always, is its extreme simplicity, which enables good results to be obtained with very little difficulty by quite unskilled operators. Of course in this method, as in others, greater skill leads to better results, not only in the direction of more perfect precipitation, but also in the prevention of unnecessary consumption of zinc and cyanide. But with plenty of alkali, and with clean tailings, the zinc is certain to precipitate a good percentage of gold from the solution, and the Charters Towers goldfield is dotted over with numerous little cyanide plants treating five or ten tons of material per day, which are owned and worked at a profit by parties of working-men usually without any scientific knowledge whatever. It may be safely said that the success of these little plants is largely due to the effective simplicity of zinc precipitation.

Some change has taken place somewhat recently in the accepted methods of cleaning up the precipitated gold from zinc boxes. Instead of the former practice of first roasting the dry precipitations and then smelting them, it is now more usual to effect a more complete elimination of the zinc by means of a preliminary acid treatment. For this purpose the wet precipitate is placed or settled in a small wooden vat, and at intervals small quantities of dilute sulphuric acid are added, while the whole mixture is well stirred up until the zinc is dissolved. Then water washes are applied to carry off the sulphate of zinc, the separation being sometimes effected by decantation and sometimes by filtration. Some operators prefer to use hot water for this purpose, and it is doubtless more rapid in its action, and therefore in large plants where proper arrangements can be provided it is of some advantage. For large works also the use of filter presses avoids the risk of losing gold through careless decantation; but, on the other hand, it may be truly said that the manipulation of such rich material should never be entrusted to careless persons.

By this acid treatment practically the whole of the zinc may be separated before the precipitates are smelted, and some economy in time and fluxes is thereby effected, but the principal objects are to avoid the losses which result from roasting the mixture of gold and zinc and to obtain a high-grade bullion. In this latter respect the different methods may be averaged as follows :—

Raw smelting bullion, 650 parts gold and silver per 1,000.
Roasting and smelting, 760 ditto.
Acid treatment and smelting, 820 ditto.

And this is of considerable importance in view of the well-known fact that purchasers pay a higher price per ounce of fine gold contained in high grade bullion than for the same gold in low grade bullion.

But before concluding this reference to the acid process a serious word of warning must be added, for its use in some cases is attended by extreme risk to life. When the ore treated contains a sensible quantity of arsenical pyrites some of the arsenic is dissolved by the cyanide and precipitated with the gold, so that the mud cleaned up from the boxes contains a large amount of arsenic. On the application of sulphuric acid, fumes of arseniuretted hydrogen are given off which are of an exceptionally dangerous nature, and in more than one instance have produced fatal results even when the operations were carried on in the open air. Acid treatment should, therefore, only be applied to such material in cases where the most perfect arrangements can be made for carrying off the fumes.

ELECTRICAL PRECIPITATION.

In this method of recovering gold progress has also been made during the last few years. In the first place, an improvement of great practical importance has been made by the substitution of small iron plates for the anodes in place of the large ones originally used, and by a corresponding reduction in the size of the frames which carry the lead foil cathodes. The use of heavy plates weighing from one to two hundredweight, and requiring two or more men to lift them, heavily handicapped the process, and the inevitable buckling of such plates is an unmitigated evil. Plates are now used about 2 ft. 6 in. deep by 2 ft. long, and are found in practice to be much more convenient, although of course a greater number of the small plates are required in a plant of a given size. Thus a very practical answer has been given to those critics who, on the first introduction of electrical precipitation, considered the large number of electrodes and connections to be a fatal objection to the process. In a modern precipitation box compartments are formed exactly as in a zinc box, and in each compartment the anodes and cathodes are placed parallel to the sides of the box. Electrically the smaller electrodes have an advantage over large ones in that the current density is more uniform over the surface of a small plate than of a large one, and when mercury cup connections are used the increased number of contacts necessary with small plates gives rise to no objectionable features either of a theoretical or practical nature. Bundles of lead ribbons instead of flat lead foil have been used in some plants, but the advantage obtained by this change is chiefly a reduction in the size of the precipitation box, while as the grade of the lead bullion is decreased the balance of advantage does not appear to be very great.

A far more important and fundamental improvement than those already named is the invention of the Andreoli anode of lead peroxide, which is prepared in the following manner as described by the inventor.* The lead plates are first immersed in a solution of plumbate of soda, in which a coating of peroxide of lead is formed upon them. They are then taken out, washed, and placed in a strong cyanide solution in which a strong current hardens the coating and gives it a crystalline appearance. The object of the inventor is to obtain a practically insoluble anode, and thereby to avoid the production of iron oxides, Prussian blue, and other more or less insoluble products which result from the use of iron anodes, and which accumulate and form a sludgy deposit in the bottom of the precipitation boxes. Of course, if the whole of the gold thrown out of solution by the current adhered to the lead foil the presence of this sludge would be a matter of very minor importance, but a fairly large percentage of the gold is thrown down and mixed with the sludge in the Siemens-Halske boxes, and the sludge therefore has to be collected and the gold extracted from it. The advantages offered by the peroxide of lead anode are, therefore, twofold—namely, the saving of the cost of iron consumed in the original method, and the avoidance of by-products containing part of the precipitated gold. Although by-products are generally unavoidable to some degree in all metallurgical operations, they are distinctly disadvantageous in gold extraction, and every effort which is made to reduce them, either in number or quantity, is worthy of the greatest consideration. At present these anodes have not been long or largely employed, and it is possible, of course, that with extended use they may show defects which will lessen or counterbalance the advantages above-mentioned, but this is a matter which time and further experience alone can show. At present, however, the Andreoli anode appears to be a distinct step in advance of the earlier methods of electrical precipitation.

PRECIPITATION BY ZINC LEAD COUPLE.

It is well-known that the efficiency of precipitation by zinc shavings decreases with the strength of the cyanide solutions, and for very weak solutions under 0·02 per cent. it is practically inadmissible. For some time, therefore, electrical methods alone were used on the Rand goldfields in connection with the extremely dilute solutions employed in the treatment of slime until the introduction of the zinc lead couple. This method is founded upon the following electro-chemical considerations. It is well known that if two metals are immersed in a liquid in which one of them is more readily soluble than the other, the former is electro-positive to the latter, and that if the two metals are placed in contact or otherwise electrically connected a current of electricity will pass from the former through the liquid to the latter. If, therefore, a mixture of shavings of two metals be placed in a cyanide solution containing gold, all the requisite conditions for precipitation are complied with, provided, of course, that the particular metals selected are competent to set up a sufficiently large electromotive force to effect the decomposition of the gold compounds. The specially favourable conditions produced in this way are a very large electrode surface and a very small liquid resistance. In the present practice, however, the couple is not formed in the manner above suggested by mixing the shavings of the two metals together, but by precipitating lead in a metallic form on the zinc in the following manner: The zinc is dipped for a few moments in a solution of lead acetate, whereby the lead is thrown down on the surface of the zinc, and thus a more perfect electrical contact is obtained between the two metals than in the case of the mixed shavings. The action of the couple may be described in the following way: The zinc being electro-positive to the lead it will dissolve in the cyanide solution, and the gold will be deposited on the lead. It is quite conceivable that after a time the whole of the lead surface may become coated with gold; but if so this will not cause the precipitation to cease, because zinc is also electro-positive to gold and the action will be continued by the zinc gold couple. It is clear, therefore, that except on the ground of expense a zinc gold couple could be used in the first place. This leads to the conclusion that the ordinary zinc process only fails with weak solutions because it cannot commence to coat itself with gold, but that if the zinc shavings are used for a little while with strong solutions, they will then be capable of dealing with dilute ones. So that in works treating both sand and slimes the boxes could be used alternately for strong and weak solutions, and the necessity for the zinc lead couple thereby obviated. The principal practical objection to the use of lead and zinc together is that no very satisfactory method of dealing with the resulting precipitates has yet been devised. Many other couples may be imagined, but owing to the complex nature of cyanide solutions, after continued use, and to the fact that the relative positions of metals in the electro-chemical series are different with different solutions, it is not easy to predict the action of any particular couple in the presence of any particular impurity in the solution. In some cases where cupriferous ores have been treated, the presence of copper on the zinc has apparently assisted the precipitation of the gold. It may also be expected that a zinc silver couple would operate effectively, and possibly zinc carbon could be employed with advantage.

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* "Electro-deposition and Recovery of Gold." Journal Society Chem. Ind., 1897. Vol. XVI. Page 96.

CHARCOAL PRECIPITATION.

In the colony of Victoria, in Australia, another method of precipitation by means of wood charcoal has been worked out and practically applied in treatment works on a fairly large scale. Theoretically it might be expected, as carbon is electro-negative to gold in cyanide solutions of working strength, that it would not act as a precipitant. The fact that it does so in practice is generally explained by the supposition that hydrogen and other gases in the pores of the charcoal really bring about the deposition of the gold. This view is supported by the fact that after a time the charcoal ceases to precipitate any more gold, and that its activity can be restored more than once by reheating it. The charcoal employed is made from local timber; it is crushed between rollers, and sized by sieving to get rid of the fine stuff in order to improve the percolation. It is placed in a number of tubs about 2 ft. in diameter, and of somewhat greater depth, which may be conveniently obtained by cutting small barrels in half. Each tub is provided with an earthenware pipe placed upright in the centre of it, and in some cases with a false bottom. Tub and pipe are alike filled with selected charcoal, and the tubs are arranged in parallel rows on an inclined floor, so that each successive row is some 3 in. lower than the preceding one. The cyanide solution from which the gold is to be precipitated is distributed between the tubs in the uppermost row, and is delivered to the central pipes. In each tub the liquor passes down through the charcoal in the pipe, and upwards through that in the tub outside the pipe, whence it passes by a launder to the next lower tub and so to the last row, whence it returns to the storage tanks. When the activity of the charcoal is exhausted in the upper tubs these are removed, the second row, is moved up into their place, and each succeeding row is moved one stage higher. When the gold-bearing charcoal has been taken from the tubs which stood originally in the first row these are filled with fresh charcoal and placed in the lowest position. Thus it will be seen that a large amount of labour is spent in moving the tubs from one position to another. But this is not the only objection to the process, the main feature being that only a very small quantity of gold is deposited upon a very large amount of charcoal. The figures, according to J. T. Lowles,* are at the South German mine about 700 ozs. of gold to 10,000 lbs. of charcoal, or to 900 lbs. of ash from the burnt charcoal. A special furnace has been introduced and patented in Australia for charcoal burning, which has a conical iron combustion chamber with a feed door at the top through which the charcoal is supplied, and a small grate at the bottom in which a fire is lighted to start the combustion. The special feature of this apparatus is that the smoke flue from the combustion chamber bends down into water in an adjacent chamber, which has also an outlet flue above the water level. A steam ejector in the outlet flue provides for the necessary draught, and all the products of combustion are caused to pass through the water on their way to the outer air with a view to the condensation or collection of any vaporised or finely divided gold that might otherwise escape. This facilitates the handling of the large quantity of charcoal, but so far as may be judged from observation only, without actually working the process, it does not seem likely that this method of precipitation will be adopted in other countries, or that its use will be largely extended in Victoria.

CONCLUSION.

The above description cannot claim to be exhaustive, because certain processes have been omitted, either because they have not altered materially since their first introduction—such, for instance, as the bromo-cyanide process used in some mines in Western Australia—and others because they are still in the experimental stage, such as the methods of precipitation by soluble salts of copper.

But it includes all the more important advances which have been made during the last few years, and exhibits as far as possible within reasonable limits of space the present condition of the science and art of the cyanide process.

The obvious moral to be drawn from it is that there is no one method which can be said to be absolutely better than all the others, for nearly every one is specially suitable for some particular class of material. Consequently the first, and perhaps the most important, problem connected with cyaniding at the present day is to determine in each case by careful study of the ore and local conditions which is the most appropriate method to adopt. Having settled this, the next most important point is to design the plant with the greatest possible simplicity compatible with the treatment to be carried on. The vats should be few in number, and arranged usually in straight lines, the pipe connections placed in visible positions, and the cocks so that they are readily accessible. In fact, this matter may be summed up by saying that the plants should always be designed from the point of view of the man who has to work in them.

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* Proc. Inst. Mining and Metallurgy. Vol. VII. Page 190.

GLASGOW ELECTRIC TRAMWAYS.

BY

BENJAMIN TAYLOR.

II.

MAIN GENERATORS.

THERE are four 2,500-kilowatt three-phase generators, with 40 poles, giving 25 cycles at 6,500 volts when running at 75 revolutions per minute. The armature is stationary, and the cast steel frame is arranged for moving sideways along the shaft. The armature core is built up of sheet-iron punchings, with rectangular slots in their inner circumference. Ventilating spaces are left in the core to allow a free circulation of air through the core and around the windings. The armature winding consists of separate coils, formed and insulated before assembling; star connected, with two circuits per phase. There are 120 coils, each coil having eighteen turns. The conductor consists of pressed cable, ·485 in. by ·275 in. triple cotton covered. The coils are held in the slots by wooden wedges, and are protected from mechanical injury by a cast-iron shield fastened to the frame, which shield also encloses and protects the connections from coil to coil. The pole pieces of the revolving field are built up of sheet iron of high permeability, securely fastened to the steel ring of the revolving field. The winding consists of forty coils, connected in series, and designed for an excitation current at 100 volts pressure. Each coil has forty-three turns of copper strip, ·17 in. by 1⅝ in., wound on edge. The normal excitation of the field, with full non-inductive load, requires approximately 250 ampères, the excitation current being supplied at a potential of 100 volts. The maximum rise in temperature after a twelve hours' run is 30 deg. Cent. in any part of the generator, and the machine is capable of carrying 25 per cent. overload for two hours, or 50 per cent. overload for fifteen minutes, without injury. These generators were supplied by the British Thomson-Houston Company.

AUXILIARY GENERATORS.

The direct current auxiliary generators comprise four 10-pole direct-coupled continuous current generators, giving 600 kilowatts at 90 revolutions per minute, at a pressure of 500 to 600 volts. These generators can operate as shunt machines at 500 volts no load and full load, and as compound machines at 500 volts no load, and 600 volts full load, and are mounted directly upon the engine shaft. The fields are circular, and of cast iron, with ten inwardly projecting removable poles of high grade cast steel. The field coils are wound separately on malleable iron spools, insulated with veneer board and oiled cotton. The armature is of the iron-clad slotted core type, with the winding of copper bars laid in slots, and insulated from the armature core by means of alternate layers of oiled linen and paper. The punchings are keyed in the cast-iron spider so that no bolts pass through the core. The end connections are of the barrel type, and are supported by, and bound down upon, extensions of the armature spider, which construction minimises the liability of damage from dust and oil. The commutator is supported on an extension of the armature spider and is integral with the armature. The bars are of hard drawn copper, and insulated from each other and the spider by means of sheet mica. After twenty-four hours' run at rated load, the temperature of armature and field coils, as measured by thermometer, is specified not more than 30 deg. Cent., and the commutator not more than 45 deg. Cent. above the surrounding atmosphere, the latter being not more than 25 deg. Cent. The machine will carry an overload of 25 per cent. for one hour without movement of the brushes and appreciable sparking, and 50 per cent. overload temporarily without flashing over or injurious sparking.

The six exciters are 6-pole machines, capable of generating 50 kilowatts each at 100 volts. They run at 300 revolutions per minute. The field yoke is of cast iron, circular in shape, with six inwardly projecting poles of the highest grade cast steel, which are removable. The fields are shunt wound for a pressure of 100 volts no load and full load. The armature is of the ironclad or slotted core type, with ample ventilating ducts. The laminations are keyed to the cast-iron spider, and no bolts pass through the core. The winding is of the barrel type, and consists of copper bars laid in slots and thoroughly insulated from the core and from each other. The end connections are supported by an extension of the armature spider. The commutator is also supported by an extension from the armature spider. The commutator bars are of hard drawn copper insulated with best mica. After twenty-four hours' run at rated load the rise of temperature of the armature or field coils, as measured by thermometer, is not more than 30 deg. Cent., and of the commutator 45 deg. Cent. above the surrounding air, the latter being not more than 25 deg. Cent. The machines will carry an overload of 25 per cent. for one hour without movement of the brushes and without appreciable sparking, or 50 per cent. overload temporarily without flashing over or injurious sparking. The main generators, the auxiliary generators, and the exciters were all supplied by the British Thomson-Houston Company.

SWITCHBOARDS.

The whole of the switchboard work was done by the British Westinghouse Company. The four main generators are connected in parallel on to three high tension bus bars, each bar having a sectional area of 0·44 square inch. From these bus bars run twenty three-core high-tension feeders to five sub-stations, four feeders going to each sub-station. The six exciter generators are arranged in parallel on the exciter bus bars, which measure 3 in. by $\frac{3}{4}$ in. in section, and to these are connected the lighting bus bars, which have a sectional area of 1 square inch. The connections for the auxiliary generators are similar to those for the main generators, except that, as they generate continuous current, only two bus bars, measuring 3 in. by $\frac{3}{4}$ in., are necessary; these generators are self-exciting. All the switch panels are constructed of polished marble, 2 in. thick. This material is capable of withstanding a pressure of 5,000 volts for thirty minutes. These marble panels have a total area of over 1,500 square feet. The main switchboard consists of four generator panels, four interconnecting panels, six exciter panels, and twenty feeder panels, the connections being so arranged that the generating sets may be either run on independent circuits or in parallel. Each of the main generators has a separate panel, which contains: One triple-pole high-tension switch for 250 ampères at 6,500 volts; three ammeters, having a range of 0 to 400 ampères, 25 cycles, one for each phase; three ammeter transformers for 25 cycles; one voltmeter, range 0 to 7,500 volts, 25 cycles; two voltmeter transformers, ratio 6,500 to 110 volts, 25 cycles; one circuit breaker; two single-phase indicating wattmeters; one three-phase integrating wattmeter; one four-point potential receptacle; one field ammeter, 0 to 700 ampères; one double-pole double-throw field switch, with discharge resistance and lamp; one field rheostat; pilot lamps. The field bus bars have a section of $2\frac{1}{2}$ in. by $\frac{3}{4}$ in., and two pairs of bars are provided, either of which can be used for exciting, and the other for station lighting.

Between the main generator panels are located the interconnecting panels, each provided with a triple-pole switch for 250 ampères and 6,500 volts. These panels enable the generators to be run on separate circuits, or in parallel, as desired. The six exciter panels and the exciter voltmeter panel are located between the generator and interconnecting panels.

The exciter voltmeter panel contains the exciter bus bar and generator voltmeters (the former provided with a double-pole double-throw switch) and a main double-pole double-throw lighting switch to enable the station lighting to be supplied from either set of 100-volt bus bars. The high-tension feeder panels are located in a separate room, in rear of the generator board, and at the same level. There are twenty panels, arranged in five groups of four panels, each panel controlling one three-core feeder, and each group supplying one sub-station. The panels of each group are in two pairs, back to back, and each group is supplied by a set of three branch bus bars, connected to a separate section of the main bus bars, which can be isolated from the adjacent sections by means of the interconnecting switches mentioned above. Each feeder panel is equipped with a triple-pole switch capable of opening 150 ampères at 6,500 volts, an automatic delayed action, overload circuit-breaking device, three transformer-type ammeters, graduated 0 to 200 ampères, and pilot lamps. The auxiliary switchboard controlling the auxiliary generators, night load feeders, boosters and station power and lighting circuits, is located on the engine-room floor under the main switchboard gallery. There are four feeder panels for the night load feeders, all similar, each containing three automatic maximum circuit breakers, three ammeters, and three single-pole double-throw switches. Twelve feeders, three from each panel, run from this board to various depots in this system. There are three station-power panels, each provided with six circuit breakers controlling six power circuits. The station lighting panel is supplied from the 100-volt bus bars above mentioned ; it contains twenty 50-ampère single-pole switches and ten fuses. Upon each of the high-tension feeders going out from the main station there is mounted a triple-pole switch for 150 ampères at 6,500 volts, while the current in each phase is measured by an ammeter having a range of 200 ampères. These instruments are also provided with transformers.

SUB-STATIONS.

There are five sub-stations, situated at good points of distribution, the whole equipment of which is by the British Westinghouse Electric Company. A description of the one at Whitevale will suffice. In this sub-station are five units, each consisting of three transformers and one rotary converter. Each set of three transformers is completely isolated from the rest of the plant by means of a brick chamber, in which it is set ; and each transformer has a capacity of 200 k.w., and transforms the 6,500-volt current from the main generating station to 310, 330, or 350 volts on the secondary side, as desired. There is one rotary converter to three transformers of 500 k.w. capacity, arranged to over-compound from 500 volts at no load to 550 volts at full load. They are of the six-pole type, and run at 500 r.p.m., and 25 cycles per second. The efficiency of the transformers is 97½ per cent. at full load and 97 per cent. at half-load, and the rotary converters have an efficiency of 95 per cent. at full load, 94 per cent. at three-quarter load, and 92½ per cent. at half-load. A three-phase induction motor is rigidly connected on the shaft of each rotary converter, and there is also a continuous current booster on the other end of the shaft for the minimising of the fall of potential of the return or negative current owing to the resistance of the rails.

The switchboards of the sub-station are situated on opposite sides of the room, the high tension on the one side and the continuous current and feeder panels on the other. The high-tension current passes through the automatic minimum cut-out switches to the high tension board, through the transformer switches to three horizontal bars above the transformers, from which it passes to the transformers. From the transformers the current, which is now three-phase but of low tension, is led back to the alternating board, from whence it is taken in ducts to the rotary converter. From the rotaries the direct current is taken in ducts to the low-tension switchboard, from which, by a series of bus bars and switches, it is distributed to the various feeding points on the overhead trolley system.

TRANSFORMERS.

The transformers are the "O.D." type, supplied by the British Westinghouse Company. The coils are wound in sections of several layers, but with few turns per layer. They are placed side by side on the core, and the ends of the coil sections are spread. The difference in potential between adjacent turns is thus reduced to a small value, and a large cooling surface is obtained. The secondary coils are wound with a square section conductor in a manner which avoids the crossing of the coils at the end of each layer. By the use of square wire the effective conductor section can be increased by about 30 per cent. over that possible with round wire. The primary coil terminals are carried on a porcelain block fixed just below the cast-iron lid of the transformer case. The secondary coils have no terminals, properly speaking, the mains being soldered direct to the coil ends. The cases enclosing the transformers are of corrugated sheet iron with cast-iron lids and bases, the corrugated iron giving a large external cooling surface.

THE TRACK.

The Tramway System is divided into five independent areas, which by means of inter-connecting cables can be connected at will. The work of supplying and laying the conduit and cables was done by the National Conduit and Cable Company. The cables are insulated with paper and protected by lead 3-16th of an inch thick, and they vary in size from ·1 square inch to ·8 square inch in section. The conduits are chiefly laid between the tracks, and are provided with manholes at a maximum distance of 500 ft., varying in size according to the number of ducts, the four sizes in use being 4 ft. by 4 ft., 6 ft. by 6 ft., 8 ft. by 8 ft., and 10 ft. by 10 ft., and all being 6 ft. 6 in. deep. There are more than three million feet of duct, equal about to 568 miles, the number of the ducts varying from six to fifty. In these ducts are laid the feeders, and these vary in number according to the position of the sub-station, but from six to twelve feeders are generally used. To prevent any possible blocking of the lines by accidents on any section, the overhead wires are all divided into sections. Return feeders are used in addition to the return by the rails, which help materially to reduce the drop of potential in the tracks. The feeder cables all terminate in feeder pillars of cast iron, situated at the edge of the foot pavement, which contain switches, by which the current is distributed to the various sections. The head office, the generating station, the sub-stations, depots, and street telephone stations, etc., are all connected by telephone.

The rails throughout are laid to a gauge of 4 ft. 7¾ in. on a bed of Portland cement concrete, 6 in. in depth, and extending to 18 in. beyond the outer rails. The dimensions of the straight track rail are : Length.

60 ft.: depth, 7 in.: width of base, 7 in.: width of head, 2 in.: width of groove, 1¼ in.: width of lip, ¾ in.: overall width, 3⅝ in.; and weigh 100 lbs. per yard. The rails are joined by steel fish-plates weighing 74 lbs. per pair, and measuring 31 in. in length, and secured in place by eight 1 in. bolts, and are tied to gauge, at intervals of 5 ft., by steel tie-bars, 2 in. by ⅜ in. in section. The rails were supplied by the Leeds Steel Works, Leeds, and by Bolckow, Vaughan and Company, Middlesbrough-on-Tees. The whole of the track and 18 in. beyond the outer rails is paved with granite setts, thoroughly grouted with bitumen and granite chips. Chilled cast-iron paving blocks are laid on each side of the rail, alternately with the granite setts, to lessen the wear and tear of the paving next the rails. At each joint there are two long No. 0000 B. and S. solid copper bonds, with Daniels' terminals through the web of the rail extending over the fish-plates, and two No. 0000 B. and S. flexible bonds with Daniels' terminals in the sole of the rail, and, in addition, the rails are cross-bonded at stated intervals.

The trolley wires, which are No. 00 B. and S. gauge, are supported by means of span wires, except where the centre-pole construction has been adopted. The trolley wire, with a breaking strain of over 5,000 lbs., is placed at a height of 20 ft. 6 in. from the level of the rails. The guard wire is of No. 7 S.W.G. galvanised steel. The span wire is of seven-strand steel, the trolley wire span being of seven No. 12 S.W.G. wire, with a breaking strain of 4,000 lbs., and the guard wire span of No. 14 S.W.G. wire, with a breaking strain of 2,000 lbs. The feeder pillar is of cast-iron, and is placed on the edge of the pavement. The height of the box from the ground level is 3 ft. 9½ in., and it contains a complete equipment of switches, etc., for cutting out any section of the overhead circuits or any of the connecting feeders. There are, besides, small section boxes on the base of the poles opposite the section insulators, each box containing a single quick-break switch for 200 lamps.

THE CARS.

The car shops of the Corporation are situated at Coplawhill, on the south side of the Clyde, occupying a total area of about 28,000 square yards. The workshops are fully equipped with the most approved machine tools for making and repairing cars, etc. The number of men employed in the works is at present about 400. Some car bodies were purchased from the Gloucester Carriage and Waggon Company of Gloucester, but all the bodies have been equipped with their electrical fittings at Coplawhill. All the cars are of the double-deck type, except a few which were built originally as an experiment for the Springburn route. The length of the car body is 17 ft., with a seating capacity for twenty-five inside and thirty on the top. The bottom frame is made of teak and the side pillars of English ash or teak. Each car is fitted with fourteen lamps, six being inside. The trucks have been supplied by the J. G. Brill Company, of Philadelphia. The length of the wheel base is 6 ft., and of the spring base 14 ft. 6 in., and the extreme length of the top plate 15 ft. 7 in. The wheels, manufactured by Miller and Company, Edinburgh, are of the best chilled iron, with a diameter of 30 in. over the tread; each wheel weighs 300 lbs. The electrical equipment of the car is, for the most part, of the Westinghouse type, and consists of two motors wound for 500 volts, two series-parallel controllers, resistances, fuse block, main motor, current switch, automatic motor switch and lightning arrester. Each motor is capable of exerting 1,600 lbs. horizontal effort at a speed of 7½ miles per hour.

FINANCE.

The cost of the track and of equipment for horse haulage when the Corporation began operations in 1894 was £349,400, plus £39,000 for Parliamentary and other incidental and intermediate expenses. The Central Power Station cost £500,000, and at present operates about 100 miles of single track, which will soon be increased. It is calculated for a service of 600 cars, and the present service is between 400 and 500. At the date of the last balance, 31st May, 1901, the amount at debit of capital was £1,793,934, off which £29,759 was written from revenue. That was the last year for horse haulage, so that the figures of revenue and expenditure give no clue to the results under electric traction, except that in the tramway year 1900-1901, on the portion of the system under electric traction, the working expenses were 45·29 per cent., and on that under horse traction 82·05 per cent., of the gross receipts. The average working expenses per car-mile were 6·62d. and 9·44d. respectively. The total number of passengers carried last year was 110,491,133, and the system is worked on halfpenny half-mile stages, with through runs of three half-mile stages for a penny.

CONCLUSION.

The Main Generating Station has been criticised as being too powerfully equipped. It is true that only two out of the four main engines have been as yet needed, but the system is steadily extending, and in the meantime arrangements have been made to utilise the surplus power in the supply of current to the Electric Lighting Department of the Corporation. A market is thus provided for the surplus energy until it is needed for the tramways. The further financial aspects of the installation, however, do not come within the scope of the present article.

NOTABLE BRITISH PAPERS OF THE MONTH.

A Monthly Review of the leading papers read before the various Engineering and Technical Institutions of Great Britain.

THE WEST AUSTRALIAN GOLD INDUSTRY.

SOME important facts relative to the progress and resources of Western Australia, and incidentally covering the progress of the gold industry, were laid before the Colonial Section of the Society of Arts recently by the Hon. H. W. Venn. A member of the Legislative Council from 1880, Mr. Venn was a Commissioner of Public Works in the first representative Government formed in Western Australia, and has since been the representative of that Colony at the Exhibitions of Paris and Glasgow. He is, therefore, especially well qualified to gauge the progress made by Western Australia. Statistics were quoted showing that during ten years the total trade of the Colony increased from £1,579,519 to £10,201,971, more than a six-fold increase, and proportionately far in excess of the increase of population. This increase is not surprising when considered in conjunction with the gold returns :—

Year.	Quantity ozs.	Value. £
1886	302	1,148
1887	4,873	18,517
1888	3,493	13,273
1889	15,493	58,874
1890	22,806	86,663
1891	30,311	115,182
1892	59,548	226,282
1893	110,891	421,386
1894	207,131	787,098
1895	231,513	879,749
1896	281,265	1,068,807
1897	674,994	2,564,977
1898	1,050,184	3,990,699
1899	1,643,877	6,246,733
1900	1,580,950	6,007,610

Last year the total export of the precious metal was 1,879,390 ozs., value £7,235,653.

During the fifteen years ensuing from 1886 the total exports were 7,797,021 ozs., value £29,722,651.

It is a big jump in sixteen years from £1,148 to £29,722,651. This, then, is the magic wand which started into activity the progress of the colony between the years named ; but it should not for a moment be inferred that, because gold has done, and is still doing, much for Western Australia, it is its sole resource, because steady progress in other industries has been made. Our export of wool up to the end of 1901 was £7,406,036; timber, £3,403,074 ; mother-of-pearl shells, £2,236,375 ; sandalwood, £1,276,660 ; copper, £208,579 ; and tin, £194,231. These figures are in themselves "letters of gold," and, when viewed from the incidence of a sparsely settled country, should bring a glow of satisfaction to the British-speaking people, because no such results, in proportion to population, have been produced by any other people of the world. There is no mistaking their import, no mistaking the influence they should exercise on the minds of the hundreds of thousands of our race desirous of a wider sphere for their energies than can be found in the Old Country.

AN ENORMOUS GOLD-BEARING BELT.

If these figures mean anything, it is that a country which enables a handful of people to send away £8,000,000 of gold annually, and to receive a revenue of over £3,000,000, must be a great one, and must have enormous crude resources to enable them to do it, and this is so. In latitude 15 deg. in the North, the locality of "Halls Creek," better known as the Kimberley Goldfields, right through the territory, there is one continuous gold-bearing belt, down to latitude 35 deg. in the South, the locality of the Phillips River Goldfield. There is thus a belt of 1,800 miles of gold-bearing country, certainly the most extensive gold-bearing belt the world has ever known. With this one fact before you, I may well ask, What are the possibilities of the State of Western Australia ? The mere fringe of this belt has only yet been touched. What can be expected from a population, all told, of less than 200,000, probably nearly two-thirds of whom are engaged in occupations other than gold-finding ?

A COMPARISON.

When we think of the enormous areas yet to be examined, as compared with those areas at present slightly mined and prospected, one feels it impossible to say what the future of Western Australia will be as mines and population increase. It may be here interesting to quote the authority of Mr. E. W. Hine, published in the Western Australian Handbook for the Paris Exhibition, as it is a comparison between the Rand of South Africa and the goldfields of Western Australia :—

"It may safely be said that in point of area, of progress, and of production the Western Australian goldfields are practically without parallel in the history of mining. On many occasions the records of the Rand, the field which in some respects most closely approaches Western Australia, have been held to be unequalled ; but output for output, and period for period, of the operations, the official figures award the palm to the Cinderella of the Australian Colonies."

For the purpose of my paper I take what may be called the corresponding years of mining development in both countries, although the dates differ. The Rand was the earlier of the two. In other respects the rate of progress shows that Western Australia was the greater.

The following table, in the case of the Witwatersrand, prepared from the chronicles of the Chamber of Mines, in the case of this country from the data collected by the Customs Department, shows the gold yield of the respective countries for six years. Though set in parallel columns, the figures it will be observed are not for parallel periods. The starting point, however, is pretty nearly equivalent. The unique "banket" deposits of the Rand were found in 1885 ; in 1886 the big rush set in, and 1887 was the year of excitement and activity. It is from the latter year that the first records of the Witwatersrand Chamber of Mines date. In Western Australia, towards the close of 1892, Bayley and Ford unearthed a mass of yellow metal at Coolgardie, which disclosed the existence of the goldfield, and gave the first great impetus to prospecting in the colony. In 1893 came the rush ; in 1894 the eastern fields were detached from Yilgarn, and declared a separate gold district. So that the periods in the lives of the two countries, set in opposition, as nearly as possible correspond :—

Rand.		Western Australia.	
	ozs.		ozs.
1887......	23,140	1894........	207,131
1888	207,000	1895...	231,572
1889 .. .	369,557	1896...... ..	281,263
1890.. .	494,817	1897.... . .	674,987
1891	729,238	1898	1,050,183
1892	1,208,928	1899	1,643,876

OTHER MINERAL RESOURCES.

If Western Australia had nothing whatever beyond her gold to excite recognition from the British investor, she is an important State. But she is conspicuous in other minerals : in copper, tin, lead, iron, and coal—vast resources of wealth in the active business of the world. Large deposits of copper are found on the north-west coast in the Pilbarra Goldfields, in the south at Northampton, again at Murrin Murrin—in the north Coolgardie Goldfields—and if the British investor has not yet realised the importance and value of these deposits, it arises from the fact that for the time being the glamour of gold investment has overshadowed all others.

COAL DEVELOPMENTS.

It is in the near future that Western Australia will be famous for her export of metals and minerals, but there is none that will be more conspicuous than the coal deposits of the State—for we have in them the basis of nearly every industry—coal in juxtaposition with limestone and iron ; and, curiously enough, until the State was actually seized of the fact that it had gold in large quantities, it did not know that a large area of coal was lying undisturbed at its feet, near a good port (Bunbury). In fact, fortune smiled on Western Australia all round. The hidden treasures of the earth seemed revealed about the same time, for active mining for coal has only taken place during the last few years, nor can I say that up to the present moment have the deposits been more than partly prospected. Developments are, however, taking place daily, money is being invested, and active operations are converting a wilderness at the Collie into a bustling coal country.

Already there is almost an exclusive use of local coal in the colony, while less than ten years ago it was practically unknown.

The change this industry is making, situated as it is in the most fertile district of the colony, is immense. Before many years elapse the port of Bunbury will be the Newcastle of Western Australia, and, when necessity and circumstances demand, the Goverment will doubtless provide the money for a coal shipping harbour.

NEW SOUTHAMPTON GRAVING DOCK.

VISIT OF THE SOCIETY OF ENGINEERS.

A VERY interesting visit was made by the Members and Associates of the Society of Engineers on Wednesday, July 16th, 1902, to the works of the new Graving Dock and the widening of the Old Extension Quay, at Southampton. A visit was afterwards paid to the Southampton Corporation Waterworks at Otterbourne.

THE NEW GRAVING DOCK.

The graving dock now being constructed for the London and South-Western Railway Company at Southampton will be the largest of six dry docks belonging to the company, all of which are in constant use. About eight years ago a somewhat smaller dock (but at that time the largest in the world) was opened by His Majesty the King (then Prince of Wales). Since that time the size and number of vessels frequenting the port of Southampton have been steadily increasing, and it has become necessary to provide more dry dock accommodation for vessels of the largest class. Accordingly, towards the end of 1899, the Directors of the Railway Company instructed their Consulting Engineer, Mr. W. R. Galbraith, M.Inst.C.E., to prepare designs for the present work, the contract for which was let to Messrs. John Aird and Co. early in 1901.

The dock will be approached by vessels directly from the estuary of the River Test, which forms one boundary of the dock estate. The river channel is being deepened by dredging to form an ample approach to it. The dock itself will be 860 ft. long (clear inside gates), with provision for extension if necessary; 90 ft. wide at entrance, with the same bottom width inside; and 125 ft. wide at cope level. The whole depth from cope to floor will be 43 ft., giving a depth of water over the keel blocks of from 29 ft. 6 in. neap tides to 33 ft. spring tides at high water. It is built almost entirely of Portland cement concrete, the floor, altars, and walls being faced with this material. The bulk of it is made in the proportion of 8 to 1, the facing to walls and floor, together with the culvert linings, being somewhat stronger, generally 4 to 1. A skin of 4 to 1 concrete is also laid on the underside of the floor, and carried up the back of the walls, so as to prevent any water which may accumulate there from soaking through the more porous concrete into the dock. This 4 to 1 concrete is made with special care, the large stones in the gravel being reduced in a crusher. A mass of 5 to 1 concrete is built in at the skewback, where the walls and floor meet, to resist the heavy crushing stress at that point.

The altars, seven in number, are all grouped near the top. They are 2 ft. 6 in. wide and only 2 ft. 9 in. high, and thus very safe and convenient to work on. Access to the floor is given by eight flights of steps, and four slides for timbers are provided.

The entrance gates, which will have a span of 90 ft. and a rise of 16 ft. 9 in., will be of steel, and will be worked by direct-acting hydraulic rams. The hollow quoins and cill quoins will be of granite from the Shap Quarries in Westmorland. The steps and timber slides will also be faced with this stone.

For emptying the dock the water will fall into large pits near the entrance. From these three large culverts will lead it to the pump wells, placed at some little distance behind the eastern wall, and at a depth of 10 ft. below the dock floor. Over these the pump house will be built, and will contain two 48 in. centrifugal pumps, capable of emptying the 85,000 tons of water in the dock in a little over two hours. Space will be provided for a third pump in case the dock should be lengthened. The boiler house will be built alongside the pump house.

The site of the dock originally formed part of the extensive mudlands on the River Test shore, which were covered by every high tide. To reclaim the site a bank was tipped round it with chalk taken from the Railway Company's cutting at Micheldever. While tipping this bank a dredger was at work within removing the top mud, which was very soft and foul. The sea-face of the reclaiming bank was pitched with stone to preserve it from storms, and covered with clay to render it water-tight. The latter process was a very troublesome one, owing to the difficulty of finding suitable clay. A supporting toe of 3 in. sheet piling was provided in places where necessary. As soon as the bank was sufficiently sealed to keep out the tidal water the enclosure was dried out with a 9 in. centrifugal pump and engine, erected just inside the bank.

Meanwhile, a 1 in 12 incline road, with a winding engine, had been built at the bow end of the dock, and as soon as the site was dried, excavation by hand gangs, by steam crane, and by steam navvy was commenced, the earth waggons being hauled up the incline and emptied on to other mudlands on the dock estate. The surface was thus lowered to a depth of from 26 ft. to 30 ft. below cope, at which level it was decided that timbered trenches should be commenced, in which the dock walls should be built.

At the entrance end, the chalk enclosing bank approaches very near the dock, and protection was given to it by driving a complete belt or dam of 12 in. sheet piling across the entrance, which in its turn is supported by raking struts. Inside this again a cross trench was sunk, so as to build the first 20 ft. of dock floor, which now forms a massive toe for the timbering. The arrangement of this timbering is worthy of notice. The wall trenches are now being sunk and timbered in a substantial manner, and directly a length is sunk to its full depth the concrete wall is started inside it. When these walls are completed the dumpling between them will be excavated in a similar fashion and the concrete floor built in, length by length. The excavation for for the pump wells, etc., is being similarly dealt with, the trench being heavily piled to avoid all risk of dislocation. Any water which finds its way into the enclosed area is led by pipes and grips to one or other of two pumps, which are provided to keep the works dry.

OLD EXTENSION QUAY WIDENING.

The Old Extension Quay was built in 1875, and has been used principally by the large vessels of the Union-Castle Line. It is a tidal quay, well equipped with hydraulic cranes and good cargo sheds, and having a minimum depth of water of 20 ft. at L.W.O.S.T. This depth, though at the time of its construction considered very ample, has of late years become quite insufficient to accommodate the large mail boats of this fine fleet. As the quay is close to the repairing factory and stores of the Union-Castle Company, and so very convenient to them, it was thought better to deepen it rather than to construct another quay elsewhere. To effect this it was resolved to dredge to the required depth (30 ft. below low-water) at a distance of 50 ft. from the existing wall, and to cover the intervening space with a platform, which would serve to widen the existing quay to deep water, so that vessels could still lie close alongside.

The design of this platform was the next problem. It is found that timber is very soon destroyed in Southampton Water by the ravages of the wood shrimp, which in a few years eats a large timber through. Accordingly it was decided to build the platform of ferro-concrete on the Hennebique system. Piles of this material are built up in vertical moulds, in which are placed the long steel rods, which really give the required strength. These are laced together with wire stirrups, and Portland cement concrete of excellent quality is carefully put into the moulds and rammed round the steel. After a month the pile is taken out of its mould and conveyed to the quay where it is driven in position much as a timber pile would be. The ram is exceptionally heavy, however (30 cwt. generally). The head of the pile, too, is protected from being bruised by covering it with a helmet or iron case filled with sawdust. Moreover, a timber dolly is always used. The whole process is novel and interesting.

The work is being carried out in three lengths, so as to interrupt traffic as little as possible. Over the first length a temporary timber stage has been erected, on which two large Lacour pile-driving engines for the permanent work have been placed. Each engine is provided with an eight-ton steam winch with which to pitch the piles and to lift the ram and other gear into position.

In the present work it was found impossible to drive the piles down to the required depth, especially in the front row, where they had to go 22 ft. into the ground through gravel and hard sand. To overcome this difficulty the water-jet system of sinking was introduced. As beds of gravel and clay occurred, it was impossible to sink with the water jet alone. Accordingly, arrangements were made to drive and pump simultaneously. The water is fed down a ¾ in. pipe buried in the centre of the pile and ending in a ⅜ in. nozzle at the point of the shoe. It is supplied from the hydraulic pressure mains, containing water at 750 lbs. per square inch. This pressure is reduced by throttling to about 300 lbs. per square inch for this work. The result has been entirely successful, and the piles are driven to their depth in less than an hour. Progress is retarded, however, by the fact that the piles and their guide timbers can only be fixed at low tide.

When the piles have been driven, the concrete round the head is to be stripped off, and the steel rods for the various beams and struts laid in position. Each set of rods is laced with wire or hoop steel, and surrounded with a timber casing. Into this casing concrete is poured and rammed, and each beam or strut thus built up *in situ*. A flooring of rolled joists and timber decking is laid on top of all. This will contain rails for the trucks and for the hydraulic cranes.

The engineer for the new dock works is Mr. W. R. Galbraith, M.Inst.C.E., and the resident engineer is Mr. F. E. Wentworth-Sheilds, Assoc.M.Inst.C.E., who has kindly supplied the foregoing particulars of the works. Messrs. John Aird and Co., the contractors, are represented by Mr. J. W. Landrey.

REVIEW OF LEADING CONTINENTAL PAPERS.

A Monthly Review of the leading papers read before the various Engineering and Technical Institutions of the Continent.

READY ENGAGEMENT OF TROLLEY WITH ELECTRIC CONDUCTOR.

WITH the method of working tramways by trolley and overhead wire, the difficulties often experienced in making the pulley engage with the wire are due to the circumstances that the groove is not wide enough and that, owing to oscillations of the pulley in a vertical plane, it is often not parallel with the wire. The arrangement invented by M. Martial Jacob for remedying this state of things consists of a shell partially enclosing the pulley and capable of turning round its pin, being fitted with two finger guides that prolong the groove by forming a wide letter V. The shell is normally kept by a spiral spring in such a position that the V guides remain horizontal. The cord for working the pole carrying the pulley passes over a guide roller and is fastened to the back of the shell so that, when this cord is pulled downwards, the shell turns on its axis, bringing the V guides to a vertical position. Owing to the wide opening between the ends of the fingers it is easy to make them engage with the wire, which is thus brought to the bottom of the pulley groove. On the cord being released, the spiral spring causes the shell to again turn upon its axis, so as to bring the fingers down clear of the wire supports. This spring must be sufficiently strong to overbalance the weight of the rope, and yet not so strong as the powerful springs that keep the pulley-pole against the wire. The Economical Trusts Committee of the *Société d'Encouragement* considers this simple arrangement as constituting a decided advance over those that have preceded it for the same purpose.

ELECTRO-MOTORS WITHOUT STARTING ARRANGEMENTS.

THREE members of the *Société Industrielle de Mulhouse* possess triphase-current power plants (two for spinning and weaving and the third for mine-pumping), in the electro-motors of which there is no special provision for starting; but for this purpose the alternators are excited from an independent source, battery of accumulators or special motor. All the electro-motors start together, just like machines driven by belt from a steam engine; and the installation is remarkably simple, while possessing a high degree of safety, since the workmen have no occasion to touch the motors. By interrupting the current of any given electro-motor, that part of the factory driven by it can always be stopped; but for starting again it is, of course, necessary to stop the whole factory. This, observes M. Kammerer in his report on the society's labours last year, is one of the disadvantages of the system. In the

MINE PUMPING PLANT,

the steam engine and generating dynamo are on the surface, and the pumps with their 150 h.p. electro-motors under ground at a depth of 180 metres (98 fath.). The starting and stopping operations are effected at the pump side of the switchboard, without the miners having to touch the electric appliances; and under ground there are only emergency interruptors, that permit of at once switching off the current in the event of accident.

CHEAPENING THE ELECTRIC LIGHT.

ECONOMY in electric lighting is only a question of heat; and accordingly efforts are now made to raise the temperature in sources of light. By simply forcing ordinary incandescent lamps an appreciably higher yield is obtained, but naturally at the expense of their constancy and duration. In most cases, however, especially when the current is charged by meter, a little sacrifice in the lamps' duration is of minor consequence compared with the increased lighting capacity. The greater the volume of the carbon filament in comparison with its length, or, in other words, the lower the tension for a given illuminating power, the more can the temperature of the filament be forced. It follows that lamps of high voltage (220 volts) are less economical than those of 110 volts, and the latter again less economical than lamps of very low voltage. In accordance with this line of reasoning, 20 or 25 volt lamps have been made, supplied by Liliputian transformers; and they are found to effect a saving of 40 per cent. as compared with ordinary lamps.

SUBSTITUTION FOR FILAMENT.

On substituting for the filament metallic oxides, or a metal fusible with difficulty, it is possible to raise the temperature still higher; and the use of metallic oxides in the Nernst lamp has naturally suggested the use of these oxides in arc lamps, whence the Bremer lamp. Herr Bremer has introduced metallic oxides into the composition of his carbons; and quite recently Herr Rasch has gone a step farther by constituting the electrodes between which the arc is formed, entirely of oxide, claiming thereby to have nearly attained the theoretical yield that it is possible to obtain in the transformation of electric energy into illuminating effect.

The light of these lamps is hotter and more economical than that of the ordinary arc, concludes M. Kammerer in his annual report to the *Société Industrielle de Mulhouse;* but it is easy to see that the question of regulating is not yet cleared up.

PUNCHING AND DRIFTING HOLES IN METAL PLATES.

IF the hole in a metal plate has to be perfect, it should be made by drilling or boring, the only rational methods for good work; and the operation of riming should never be effected at the same time as the punching, because its general object is not merely to enlarge holes, but also to make them coincide, thus necessitating two distinct operations, and in such a case the tool with circular motion is preferable to to that with rectilinial travel. With the object of obtaining cylindrical holes with smooth and regular surface the use has been proposed of punches with multiple cutting edges, following up the principal cutting surface which drives out the disc, or burr.

THE FREMONT PUNCH

comprises a series of parallel circular cutting edges which operate one after another, the line of cut being a conical helix, while in one variety several such lines facilitate disengagement of the cuttings. Such punches have been tried for copper and iron at the Hellemmes shops of the French Northern Railway, but were not found to be practical, being too complicated, kept in order with difficulty, becoming clogged, and breaking at the edges, or turning out bad work. In addition to this, the cutting edges soon become blunt, so that the metal is forced out sideways, with great expenditure of power, while the travel of the punch is necessarily far greater than in the ordinary arrangement.

The above observations were made in a communication to the *Société d'Encouragement* on the work of machine tools, by M. Codron, who had carried out some experiments for determining the maximum effort that must be exerted on a drift for transforming cylindrical into square holes in pulleys, wheels, and spur-gear. Such a drift, which may be employed to advantage when the operation has to be oft repeated, is used for transforming a hole of 80 mm. (3·15 in.) diameter in the boss of a cast-iron wheel into one of square section with the corners rounded off. The drift is formed by stringing together twenty-eight steel plates of the desired form, kept apart by iron washers, on a rod of 38 mm. (1·49 in.) diameter; and for releasing the shavings the plates are cut out (or made smaller) at alternate ends or points. The total thickness of metal to be removed is 8 mm. ($\frac{5}{16}$ in.); and, as the last three cutting plates are to gauge, so that they scarcely remove any metal, each of the remaining plates removes $8 \div 25 = 0{\cdot}32$ millimetre. The drift is forced through in six minutes, so that the speed per second is about 4 mm. ($\frac{5}{32}$ in.); and the power absorbed towards the end of the operation may be put at 33·32 kilogrammetres (240 foot-pounds).

ALLOYS OF CADMIUM AND MAGNESIUM.

FACTS similar to those pointed out by Sir Roberts-Austen as regards gold and aluminium, by H. Gautier for antimony and aluminium, and Lebeau for antimony and lithium, have also been observed by M. O. Boudouard with respect to cadmium and magnesium, viz., that certain combinations of these metals are less fusible than either of them separately. As stated before the Paris Academy of Science by M. Troost, M. Boudouard has formed graphic diagrams by laying off on the abscissæ the proportions by weight of the magnesium added to a given weight of cadmium, and the temperatures on the ordinates, when he found that the curve presented three maximum and two minimum points, of which the former show the existence of three well-defined combinations—$CdMg$, $CdMg_4$ and $CdMg_{30}$. Preparation of polished surfaces of the various alloys for examination by the microscope presents great difficulties owing to the slight hardness of the substances; and sometimes, also, the alloys are easily attacked by water, so that a perfect polishing is difficult, if not impossible. These alloys are, concluded M. Troost, of white hue, more or less brilliant; and they are tolerably soft, being easily filed, while as regards malleability, they break when hammered repeatedly, those containing equal parts of the two metals behaving best in this respect. Cadmium and magnesium alloys preserved in closed flasks are not subject to appreciable alteration in air; but this is by no means the case when water is present.

CONTINUOUS RAIL FOR MAIN LINES.

FOR suppressing, or, at any rate, greatly diminishing, the shock given by passing trains at the gap left for expansion between two rails, M. Jules Schaeffer, of Luxemburg, proposed to cut the rail ends along a vertical plane oblique to the vertical longitudinal plane; and a piece of line near the Dudelange Iron and Steel Works was laid according to this arrangement, with highly satisfactory results.

The subject of, suppressing this shock by rendering the rail continuous was lately brought before the *Liége Engineers' Association* by M. A. Stévart, who referred to the two principal methods for bringing this about—the electric welding of the rail ends and the Falk method of surrounding the rail ends with a mass of cast iron from a travelling cupola. In laying a new line there is no difficulty in rendering rails continuous; but in the event of repairs the work is difficult because the rails must be very clean. Can this system, he asks, be applied to main lines? Reckoning on a temperature difference of 50 deg. Cent. (90 deg. Fahr.) and an expansion co-efficient of 0·000108, it is easy to prove that the resulting compression strain attains 10·8 kilogrammes per sq. mm. ($6\frac{1}{2}$ tons per square inch). Such a strain would not be excessive were it not that the chief stress on the rail is due to the deflection caused by the passing load; and if this compression or elongation strain be not attained, deformation of the track will ensue. Some authors assert that the track will not suffer deformation on account of friction on the ballast. M. Stévart thus arrives at the total effort sustained by the rails:—

Supposing the rails to weigh p kilogrammes per running metre, the effort for each rail will be

$$\frac{p \times 10{\cdot}8}{0{\cdot}0078} = 1380\, p.$$

For the values of p, varying between 40 and 50 kilogrammes per metre (mean 90 lbs. per yard), the above-mentioned effort will be comprised between 55·2 and 69 tons. The track on the straight will therefore be subjected to the tension or compression strain by a total effort of 110 to 140 tons.

If we suppose that the strain is one of compression, two hypotheses are possible—either the line will remain straight or it will suffer deformation.

In the latter case, if l be the length of the rail, i the elongation per running metre, and f the amount of deflection,

$$f = l \sqrt{\left(1 + \frac{l}{2}\right)\frac{i}{2}} = 0{\cdot}104\, l.$$

For a length of 9 m. (29½ ft.) *f* will equal 15 cm. (5·9 in.) and for one of 12 m. (39¼ ft.) *f* will equal 20 cm. (7·8 in.).

M. Stévart remarked that in such a case the piece of straight line would be transformed into a sinusoid, so as not to permit the circulation of vehicles ; but he is of opinion that the extreme deflection thus calculated would not be realised, and that the strain on the rail would result from the deflection and the diminution of length combined. It also appears evident from calculation that in the case of a curve, as on the straight, there will be deformation due to simultaneous deflection and compression.

WHAT RESISTANCE MUST BE OPPOSED TO THE LINE TO PREVENT DEFORMATION BY DEFLECTION?

If R be the radius of the curve, we shall have for the value of the compression effort $F = R\,f$; and for $R = 250$, 400, 500, and 1,000, $f = 400$, 250, 200, and 100 respectively. In many cases f will not be greater than these figures, but will nevertheless have a determined unknown value.

THE CONCLUSION ARRIVED AT

is that no extreme effect will be produced. The line will present impracticable undulations; and the supplementary strain on the rail will, in any case, be disadvantageous, in addition to which the metal will be deteriorated at the welded joints.

THE IRON-MAKING AND SHIPBUILDING INDUSTRIES IN GERMANY.

THE fact that the summer meetings of the Schiffbautechnische Gesellschaft were this year held in a centre of German iron production (Düsseldorf), was to a certain extent responsible for a comprehensive paper on the above subject, contributed to that body by Herr E. Schroedter. In this, the general development of the iron industry and shipbuilding in Germany is first sketched, the author then proceeding to institute a comparison between these industries in the countries where they chiefly flourish. He finally discusses the special conditions, which come into question in regard to the origin, quantity, nature, and nomenclature of the various productions.

AN INTERESTING COMPARISON.

The author shows the iron and steel outputs of England, France, America, and Germany, in direct comparison with their shipbuilding tonnages. The diagrams which accompany the paper are significant.

> We see that, up to the close of the century, Germany has, in the production of pig iron, followed close on the heels of the United Kingdom, and has, in the production of steel, even surpassed it. German shipbuilding, on the other hand, although marked by great advances from a technical point of view, and holding an unbeaten record in the case of the performances of a few vessels, has, as regards quantity turned out, not developed in a corresponding degree, and does not now amount to one-seventh of the English shipbuilding output. In view of this, a report on the shipbuilding of Germany, which I found in the *Iron and Coal Trades Review* of December 20th, is not far wrong in the assertion that beside the shipbuilding of Great Britain it makes a very poor show. As a matter of fact, Germany's whole shipbuilding output does not exceed that of the yards of one of the rivers on the north-east coast of England. While the needs of the shipbuilders form the backbone of the output of the English iron trade, the industry in Germany can reckon only on a comparatively small demand for the home shipbuilding industry.

It is shown that, thanks to the tireless exertions of German plate-makers, the iron-making industry of the country in regard to output as in regard to producing power, has wonderfully increased. The following account is given of the history of the manufacture of German armour plates :—

THE FIRST GERMAN ARMOUR PLATES.

The manufacture of armour plates in this country was begun in the year 1876, after the German Admiralty had, for a while, been engaged in the construction of armour-clad vessels in its own yards, and it was a matter of interest to them that these vessels should be built, as far as possible, entirely of German material, and in home yards. It was Admiral Stosch in particular who powerfully supported and furthered this undertaking, and it was in the first place due to his initiative that this question of obtaining armour, so important for warship building, was, in the very beginning of our naval development, taken up by a German iron company, and inaugurated by the laying down of large new plant, which could only be applied to this special purpose.

The first works that produced ship armour plates in Germany was the Dillinger Hüttenwerke, and their first delivery consisted of the armour for gunboats of the *Wespe* class, which were protected by 8 in. wrought iron plates. Following this came the 6 and 12 in. armour for the two corvettes, *Würtemberg* and *Baden*, and that used in the re-armouring of the corvette *König Wilhelm* in the year 1880. This was the last wrought-iron armour fitted to a German vessel, and had the thickness of 12 in.

The wrought-iron armour plates used for the abovementioned vessels were, in regard to their resisting power, fully as good as those at that time produced by English works. The resisting power of the wrought-iron armour could not keep pace, however, with the ever progressing improvements in guns and projectiles, and it therefore became necessary to replace the soft wrought iron by a hard material.

COMPOUND ARMOUR INTRODUCED.

After the year 1877 a compound armour (steel-faced armour plates on the Wilson system) had come to the front, which consisted for two-thirds of its thickness of wrought iron, but the front of which was of hard steel. The idea of this armour was that it should offer great resistance to a shot striking its hard steel front, while the soft tough iron backing was to prevent the plate from being shattered. Plates of this kind showed, in the course of firing trials, a considerably increased resistance to the action of projectiles.

The method of manufacture was patented in Germany as well as in England, and in the year 1880 the Dillinger Hüttenwerke purchased the right to its exclusive use in Germany. In the same year a beginning was made with the extensive plant necessary for the new manufacture, and in December, 1881, the first compound plates were sent to undergo ballistic trials.

After the results of these trials had satisfied the German Admiralty that the Dillinger Hüttenwerke were able to produce compound armour that was quite as good as that made in England, the first order was placed with this firm for the deck armour of the gunboats *Brummer* and *Bremse*, as well as an order for armour of from 10 to 12 in. in thickness for three Chinese armoured corvettes, which were built in the yard of the Vulkan in Stettin.

At first the German armour-clad, H.M.S. *Oldenburg*, was fitted with compound armour of from 10 to 12 in. in thickness, which was delivered in the years 1884 to 1885. Except during a pause of two years, during which time no plates were used for new vessels, the delivery just alluded to was followed in succession by several others for compound plates, extending down to the year 1892. Amongst these were deliveries for vessels of the Bradenburg class with plates of thickness up to 15 in. (400 mm.), and of weights up to about 29½ tons. The largest output of armour plates in a single year did not exceed 1,970 tons.

The manufacture of the compound plates was very troublesome and required great skill on the part of the workmen, and a very reliable quality of material. The forging of the large iron plates, ranging up to 40 tons in weight, and the pouring of the molten steel on to the white-hot wrought iron plate was a difficult undertaking for the ironmakers of that time. As far as the connection between the steel and the iron parts was concerned, the plates made in Dillingen were always distinguished by very close and reliable union.

KRUPP ENTERS THE FIELD.

When, towards the close of the eighties, the German Admiralty began to build considerable numbers of new vessels, the firm of Krupp was persuaded also to proceed with the manufacture of armour plates. Before the year 1891 this firm had only produced armour plates in small quantities for their own experiments, and principally to try their projectiles upon. In the year named a new rolling mill for the manufacture of ship armour plates was set to work.

This rolling mill was, in the first instance, arranged for the manufacture of compound armour, but it was found possible without much difficulty to change it for the manufacture of steel plates, the production of which the Krupp firm had in view from the very beginning. The sole right of using the patent for Wilson's system in Germany had been ceded to the "Aktiengesellschaft der Dillinger Hüttenwerke." Krupp now came to an agreement with this firm for the manufacture of these armour plates in common with them. By this patented process, the Krupp firm made about 2,000 more tons of armour plates, most of which were for the armour-clad ship *Wörth*, and a smaller portion for the armour-clad *Kurfürst Friedrich Wilhelm*.

NICKEL STEEL ARMOUR PLATES.

Almost at the same time as these plates were being made, the Krupp firm proceeded to make experiments as to the production of nickel steel armour plates. Experiments made in this direction, on a small scale which turned out successfully, and were, in the sequel, continued by the Krupp and Dillinger firms together, with the result that in the year 1892 plates made of unhardened nickel were adopted. This new method was characterised by a very exceptional degree of toughness, combined with a very satisfactory power of resistance, which was considerably greater than that of the compound plates.

It may be taken that, whereas a compound plate has the same power of resistance as an ordinary plate of 1·4 times its thickness, these new nickel steel plates had a power of resistance 1·6 times as great. Plates of this kind were, for the most part, supplied by Krupp for the armour-clad vessel *Kurfürst Friedrich Wilhelm*, and by Dillinger for the armour-clad vessel *Weissenburg*.

FURTHER DEVELOPMENTS.

As the result of continued experiments carried on by these two firms in common, a new quality of armour plate was introduced in the year 1893, consisting of nickel steel of medium hardness, which was subjected to hardening by oil.

These armour plates, with almost the same toughness as before, were, in comparison with the previous quality, characterised by an increased power of resistance, which was about equal to that of an iron plate of 1·72 times their own thickness.

The coast defence vessels, *Heimdall*, *Hildebrand*, *Odin*, *Aegir*, etc., are fitted with armour of this kind. The completion of these orders was followed by a pause in the manufacture of armour plates, which was utilised by these firms, each acting independently, to pave the way for further progress in the production of armour plates.

At that time plates were already produced which were hardened on Harvey's system. The Dillinger Hüttenwerke made an arrangement with the Harvey Company, on the strength of which a few experimental plates were produced in the works of the former, and offered to the German Admiralty for trial.

The results obtained, however, did not induce the German Admiralty to introduce this system for the armour of their vessels.

"KRUPP" PLATES.

The Krupp firm continued their experiments, which led them, in the year 1893, to the production of a nickel-steel plate hardened on the front, which was exhibited at the Exhibition in Chicago, and proved considerably superior, as regards toughness and power of resistance, to those made on the Harvey system. At the same time, this firm improved the quality of the unhardened armour plates, and in the course of the year 1894, a quantity of plates were supplied for the Spanish armour-clad vessel, *Emperator Carlos V.*, of a material which was about equal to that of wrought iron of twice its thickness. As the German Admiralty did not during this year require any armour, the Krupp firm, towards the close of the year 1894, were able to produce a considerably improved hardened armour plate. The quality exhibited in Chicago, as before mentioned, was never produced in other than experimental quantities. Instead of this, from the year 1895 onward a hardened nickel-steel plate was produced, the power of resistance of which was, on the average, as great as that of a wrought iron plate of three times its thickness. Since the year 1895 this quality exists solely for the use of the German Admiralty, the Dillinger Hüttenwerke having in the meantime also purchased the right of making use of the system. After this a few plates only of very complicated shape, or of very small thickness (below 3⅛ in. = 80 mm.), were still made of the unhardened nickel-steel used for the *Emperator Carlos V.*

The new plates are generally known by the name of Krupp-plates, and such plates are now produced according to Krupp's method by almost all the armour-making works of the world. The English works, in particular, were quick to perceive the superiority of the Krupp products, and to adopt the manufacture on that system, the firms who did this being Vickers, Sons and Maxim, Charles Cammell and Co., and John Brown and Co.—all three in Sheffield. These were followed at a later date by Armstrong, Whitworth and Co., of Newcastle. The Russian State works in Kolpino and Obuchow also make plates exclusively on the Krupp system. The same applies to Witkowitz.

In the American service Krupp plates are also introduced, and are made by the Carnegie and by the Bethlehem Steel Companies. The French works, Schneider et Cie., the works of St. Chamond, and Chatillon and Commentry hold licences for the use of the Krupp patents, as also does Terni in Italy.

In addition to the plates required by the German Marine, Krupp has delivered plates made on this system to Russia, Austria, Holland, Sweden and Norway and Japan.

No consignment has ever been condemned by the purchaser during all the trials of plates delivered by the Krupp Works. The Krupp plates stand, as regards quality, unequalled. Side by side with their great power of resistance they have always possessed an extraordinary toughness. The Krupp methods, the details of which are not published, are distinguished by an extraordinary certainty in the working and homogeneity in the article produced.

The capabilities of the German works are so great that they are able not only to fulfil all the requirements of the German Admiralty, but also to deliver large quantities of armour to other countries that do not possess works of their own. The best proof that the existing arrangements are able to cope with the greatest requirements likely to be made in regard to dimensions is the 104-ton plate, measuring 43 ft. 2 in. in length, by 11 ft, 2 in. in breadth, by 11¾ in. in thickness (13·16 m. by 3·4 m. by 30 cm.), which is exhibited in front of the Krupp Hall at the Düsseldorf Exhibition.

IMPRESSIONS THAT PROVE.

(A SEQUEL TO OUR FIRST NUMBER.)

THE first number of Page's Magazine has come, and we are happy to be able to add *gone*, the trade having shown its appreciation by securing every available copy, so that with the exception of a few magazines kept in reserve for annual subscribers, our first edition has passed into circulation to be weighed in the keen balance of public opinion.

Having taken exceptional pains to secure success and to render the Magazine foremost in the field it occupies, we were confident that we could rely upon the reading public to treat the new venture on its merits ; but we must confess that the hundreds of flattering press notices and private letters from journalistic and other gentlemen which have poured into the editorial office since the appearance of our first number indicate a standard of appreciation far in excess of our most sanguine anticipations. In view of the marked and kindly interest already evinced by our readers in the future prosperity of the Magazine, we give below a few brief extracts from representative criticism.

The Times.—Mr. Page deserves special praise for the attractive form he has given to the Magazine.

Truth.—America has been allowed to get ahead of us in the production of technical periodicals, just as she did with popular illustrated magazines. The reproach to our enterprise in the latter case has been wiped out, and it is gratifying to see that the same process is taking place in the department of trade journalism. A notable instance of this movement is furnished by the new illustrated monthly which has appeared under the title of Page's Magazine. Concerning itself with the engineering, electrical, shipbuilding, iron and steel, mining, and allied industries—a sufficiently comprehensive sphere of interest—it compares favourably in every respect with those American magazines on the same lines which have hitherto been practically unrivalled in this country. Mr. Davidge Page, the editor, was, until recently, the English director of the best known of the American engineering monthlies circulating in this country. In the face of the pessimism that prevails in so many quarters, it is satisfactory to find that the new Magazine takes a hopeful view of the position and prospects of our engineering industries.

The Morning Leader.—We admire the spirit in which our new contemporary starts upon its mission. Regarded as a literary and artistic production, its first number at once secures high rank.

Pall Mall Gazette.—Page's Magazine has just come into what promises to be a vigorous existence. A number of first-class photograms have been irreproachably produced on the ample pages of this comprehensive engineering monthly.

The Daily News.—There seems to be an opening for the new illustrated technical monthly, Page's Magazine, even if it does not, like so many advertised inventions, supply a "felt want." It is rather anomalous that the two principal engineering monthly magazines hitherto published in this engineering country should be American. The text portions are printed in New York, and the sheets sent over here and bound up with local advertisements. Hence they have to go to press several weeks in advance of publication. The new monthly, on the other hand, being edited and printed in London, will be quite up to date. Great Britain ought to be able to sustain a high-class engineering magazine of this type.

The Daily Express.—The proprietors of Page's Magazine need have no fear as to the nature of its reception. It will be welcome wherever those subjects interest, and those industries are seated. All the precedents call for perfection of paper and printing in a magazine of this kind, and Page's acts up to those precedents in the fullest measure. Further, it contains more and better articles than one could reasonably expect for a shilling.

Impressions that Prove.

The Caxton Magazine. The official organ of the Institute of Printers. The excellence of American typography and process work has deservedly received high recognition, but American magazines printed in New York and sent over here in the sheet to be bound up with English advertisements, are handicapped by an inherent defect. It is not in the nature of things that they should be completely up to date. This fundamental difficulty must have frequently impressed itself upon Mr. Page in his efforts to meet the demands of English readers for the latest information on engineering subjects, and it is not surprising, therefore, to find him determined to make an end of Trans-Atlantic dallying, root and branch, by issuing a magazine written for Englishmen by the best English writers, with a make-up of articles which bear the stamp of to-day, and are suggestive of ink fresh from the pen and scarcely dry. One effect of this notable advertising display is to render the strictly business portion of the paper exceptionally interesting; in fact, it is safe to assert that never in the history of technical publishing has such a unique collection of engineering advertisements been brought together in a preliminary issue.

The Daily Chronicle.—Will prove a welcome addition to the British technical press. The interchange of technical results across the Atlantic has long been going on, as every student of the papers read at the various institutions is well aware, and although we have our own high-class weekly scientific journals, there certainly seems to be a place for the editor's programme.

Daily Graphic.—In the qualities of its paper, printing, and general get-up, the new Magazine is above the standard of kindred periodicals. The factor foremost and indispensable, however, is information, technically trustworthy, up to date, and intelligent. In such information PAGE'S MAGAZINE excels, and it promises to be a production of much value and interest.

Morning Advertiser.—The first number makes a good bid for popularity. The paper and printing are very good, and the numerous illustrations are all that could be desired both in the way of execution and interest. The producers of the Magazine are to be congratulated on their initial effort, and will doubtless receive that large measure of support which it thoroughly deserves.

Echo.—The new engineering magazine has arrived. For months it has been talked about, but now PAGE'S MAGAZINE has shown how they are able to fulfil promises. Their "Naval Notes" are exceedingly well done, whilst "Developments in Cyanide Practice"—the first of a series of articles on modern mining practice—reflects the skill and knowledge of Mr. Edgar Smart.

The Sun.—In the new illustrated technical monthly the Americans find their first rival in this country.

The Evening Standard.—The reader who studies the contents of PAGE'S MAGAZINE in a month will be industrious. It is a new magazine, but it is enough to say that in its illustrations of machinery of all kinds, and in its literary matter, it takes rank by the side of its older competitors at a single bound.

The Morning Post.—The first number covers a wide field of scientific production, while also containing many well executed pictures of electric plant and other machinery, shipping and tramway works, cyanide practice and naval construction, all of which are explained in well-considered articles.

The St. James's Gazette.—The Magazine is beautifully produced, and should be useful to engineers, shipbuilders, and those engaged in the iron and steel, electrical, and mining industries. The articles are well written, and the photos well engraved.

The Railway Times.—An advanced copy of PAGE'S MAGAZINE makes it apparent that a new level has been attained in the high-water mark of English technical publishing. Considered simply as an aggregation of printing, engraving, and paper, the first issue is certainly worth its nominal cost, while the tone and quality of the illustrations leave nothing to be desired. The newcomer has an exceedingly healthy look, and should leap into immediate favour with a large circle of readers at home and abroad. It will be a specially welcome edition to the library of the busy man, who wishes to keep himself *au courant* with the applied science of the day, and we certainly find ourselves in agreement with the *Times* in its opinion that the editor deserves special praise for its attractive form. A comprehensive view of the first issue impresses us with the fact that the two American technical magazines have found a competitor whose merits will be recognised by English readers with unanimity. The illustrations throughout the number are of a high order; indeed, we doubt whether a corresponding degree of excellence has ever been previously attained in the first issue of a technical magazine.

Engineer.—The first number is a highly creditable production.

Electricity.—The first number makes a strong bid for electricians. "Naval Notes" deal pithily and well with the burning question of naval progress, and are illustrated in a style far beyond that achieved by any of the other technical magazines.

Shipping Gazette.—Judging from the first number of PAGE'S MAGAZINE, there is every promise that the proprietors will bring to this important work high technical skill and well-directed enterprise.

The Syren and Shipping.—Up to the present we have had to rely on the United States for engineering magazines, and certainly Cousin Jonathan has catered for us splendidly; but he is no longer to have the field to himself, for PAGE'S MAGAZINE promises to run him close. It is profusely and excellently illustrated, well got up, and will, we should think, assuredly catch on.

Glasgow Herald.—Well written and well illustrated.

Sheffield Telegraph.—Altogether, judging from the initial number, PAGE'S MAGAZINE should stand in the first rank as a technical periodical.

The Manchester Courier.—The first issue of PAGE'S MAGAZINE, from an engineering point of view, must stand pre-eminent.

Birmingham Post.—The Magazine is beautifully printed, and the illustrations are all that could be desired. The editor and publishers are to be congratulated on their initial issue.

Leicester Post.—Judging from its first number the new monthly makes a strong bid for success, being in every respect admirably adapted to win the golden opinions of the representatives of our English engineering industries.

The Nottingham Express.—The new Magazine starts its career in a promising fashion.

The Western Mercury.—That there was room for a production of an English magazine of this description there is no doubt, and in PAGE'S MAGAZINE all interested in the professions and industries with which it deals, may rely upon having the opinions of experts and the latest views.

Yorkshire Observer.—The proprietors of PAGE'S MAGAZINE have learned all that America can teach us, and then determined to "go one better." Certainly, the first number may go to America and challenge comparison with the best work done there. Editorially, the arrangement is admirable, and the Magazine, if kept on the high level which is taken by this first number, is bound to jump into the first place among such publications.

Edinburgh Evening News.—The Magazine is well printed, and the large size of the pages gives a better effect than usual to the numerous illustrations.

The North Eastern Daily Gazette.—The whole production of the first number with respect to quality of paper, excellence of printing and illustration, and the character of the articles, justifies the high claims put forth by the editor.

Huddersfield Examiner.—The Magazine takes a world-wide range over engineering interests, and gives the results of its survey in a manner calculated to strongly impress the casual observer by the splendid style in which they are presented, and the more careful student by the thoroughness of its researches.

Northern Whig, Belfast.—This number augurs well for the success of the venture. Edited most capably, PAGE'S MAGAZINE has, unless all appearances are deceptive, come to stay.

Plymouth Mercury.—PAGE'S MAGAZINE will possess the great advantage of being thoroughly up to date in news and illustrations.

Devon and Exeter Gazette.—The articles are brimful of information.

The Bristol Mercury.—The numerous subjects dealt with are treated in an able and informing fashion.

Aberdeen Free Press.—PAGE'S MAGAZINE makes a very promising start.

Liverpool Courier.—It is a most promising production.

The Yorkshire Post.—PAGE'S MAGAZINE is an enterprising and very business-like publication, and is, in its own way, an effective reply to American competition.

Bristol Press.—It is likely to have a successful future.

The Stock Exchange.—A perusal of the reading matter will be the publication's best recommendation to the technical mind. Its success seems already assured.

Money Market Review.—Bulky in volume as a quarterly review, printed on thick, glossy paper, apparently regardless of cost, full of pictures and plans as perfectly produced as is possible in these days, when the camera has well nigh ousted the pencil in magazine illustration, PAGE'S MAGAZINE comes forward into the fierce light of popular criticism under excellent auspices. Hitherto nothing equal to the Magazine has been entirely produced in England.

Capitalist.—It is an admirable production.

Financial Chronicle.—Well illustrated, the first number of PAGE'S MAGAZINE reflects credit upon all concerned.

Joint Stock Companies' Journal.—If the same high level of excellence is maintained, we have not the slightest doubt of the success of the Magazine.

Investors' Review.—We are very much taken with this new Magazine, and trust it will have a long and prosperous career. The first number is now before us, and is not only sumptuous in its get-up, but packed with matter of varied interest to engineers and men of business in the lines dealt with by the Magazine. Altogether a most appetising assortment.

Financial Times.—PAGE'S MAGAZINE, which has just made its appearance, proves that it is quite possible to produce in this country a periodical which, so far as production is concerned, will hold its own with American rivals. . . . Judging from the letterpress and illustrations, it will no doubt secure a large and influential *clientèle.*

The Financier and Bullionist.—The first number of PAGE'S MAGAZINE is a credit to everybody concerned in its production. It is a massive publication, bearing the hall-mark of distinction.

Money.—The Magazine is beautifully illustrated, and is printed throughout in high-class style. Should the high standard of the first issue be maintained, and it is clearly the intention of the proprietors to so maintain it, there will no doubt be a large demand for the Magazine.

Lloyd's Weekly Newspaper.—The Magazine is beautifully printed and illustrated, and contains the latest information anent each of the industries it deals with.

Review of Reviews.—It is excellently printed on good paper, which enables justice to be done to the immense number of blocks. Altogether, the Magazine seems admirably adapted to the public to which it appeals ;

and, judging from the number of advertisement pages in the first number, it starts with every prospect of success.

The Sovereign.—It is seldom that a magazine makes its first appearance looking like a veteran, and with something like 112 pages of advertisements. Such, however, is Page's Magazine. It is remarkably well printed and illustrated, and the articles are well written by authors who are masters of their subjects. The new venture is pretty sure of success.

The Army and Navy Gazette.—The Magazine is of high class, and deserves to succeed.

Vanity Fair.—Page's Magazine should at once become a very popular trade journal in its own sphere, for it is exceedingly well done.

Economist.—It covers ground not occupied at present by any other publication, and will prove a valuable and useful addition to our trade literature.

The Empire.—Page's Magazine deserves the support of all who are directly or indirectly interested in the maintenance of British supremacy in the domains of engineering, shipbuilding, and other important industries.

The Whitehall Review.—We have received a copy of a splendidly printed and ably written publication, entitled Page's Magazine. The text is supplied by the highest authorities in their various departments. Altogether it is a fine publication.

World.—Page's Magazine will certainly appeal to a very large public. . . . To the expert the Magazine cannot fail to be welcome. It is admirably produced, printed, and illustrated.

Commercial Intelligence.—We wish our new contemporary every success, which, if the standard of the first number is maintained, will be well deserved.

City Press.—The get-up is admirable, displaying a marked improvement on what is customary in trade journalism in Great Britain. The new venture starts with every promise of becoming, ere long, a powerful rival of the several magazines that are conducted on somewhat kindred lines.

East Anglian Daily Times.—There is a vigour and freshness in the presentation as a whole which savours of American smartness without the tawdry dressing of trans-Atlantic prints. The illustration of the new magazine, both photographic and design, is all that could be wished for ; and a soothing artistic element is present that removes some of the forbidding harshness of other engineering publications that have received our attention.

The Bath Herald.—Few new publications which have come under our notice lately have more favourably impressed us than the first issue (July) of Page's Magazine, which fills a distinct want. There should undoubtedly be a bright and prosperous future before so admirably equipped a technical magazine as this.

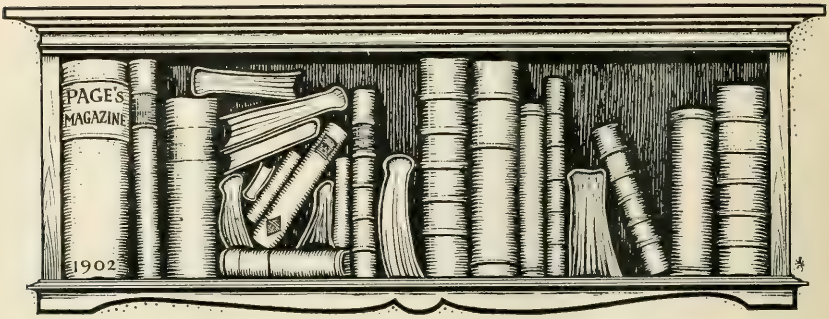
Bristol Times and Mirror.—The first number is a credit both to editor and printer.

Sheffield Independent.—Altogether a remarkable example of what can be done for a shilling in the periodical literature even of industries so keenly alive to the value of advertising as those with which it deals.

Glasgow Evening News.—As regards subjects, matter, paper, printing, or illustrations, this latest production equals, if not surpasses, any similar production, British or foreign, and gives promise of even better things in the future.

Illustrated London News.—The two American engineering magazines at present circulating in this country are printed in New York, and are sent over here in the sheet to be bound up. These have, therefore, to go to press several weeks in advance of publication, while Page's Magazine, being edited and printed in London, will be absolutely up to date. In point of illustration and general arrangement it is excellent.

Railway News.—We are glad to see that Page's Magazine proposes to take a healthy view as to British industries, and is not going to join the howl of those journals which think that England's days are numbered, and that it will soon only be a dependency of American energy.



BOOKS OF THE MONTH.

In this department special attention will be paid to all books dealing entirely or in part with subjects within the *purview of the Magazine.* While space will be given for expressions of opinion on books or papers of general interest which may be submitted for that purpose, contributors will please remember that this column is intended in the main for reviews of technical books dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining, and Allied Industries. The address of the publisher and prices should be enclosed in all publications sent for review.

The Balancing of Engines. By W. E. Dalby, M.A., B.Sc., M.Inst.C.E., M.I.Mech.E. Edward Arnold. 10s. 6d.—In this valuable work Professor Dalby attacks a problem which during the last decade has gradually forced itself upon the attention of marine engineers. Vibration troubles at central stations and many cases of undue wear and tear, and hot bearings in mills and factories are also frequently attributable to unbalanced machinery, and by dealing with the whole subject in a comprehensive and masterly manner, the author has undoubtedly done valuable service to engineering science. Manufacturers of high speed engines or other rapidly rotating machinery, will welcome the book as a most important accession to technical literature. The semi-graphical method here developed can be applied by the engineer to everyday balancing problems, not only with regard to engines, but in connection with machinery of all kinds. Chapter I. deals with the addition and subtraction of vector qualities; Chapter II., with the balancing of revolving masses. In the succeeding sections the Professor deals with the balancing of reciprocating masses; the balancing of locomotives; the motion of the connecting rod, etc. There are numerous diagrams and illustrations.

Elementary Coal-Mining. By George L. Kerr, M.E., M.Inst.M.E. Charles Griffin and Co., Ltd. 3s. 6d.—This is a good practical introductory text-book, prepared from the author's larger work on coal-mining, and designed to meet the requirements of the Examination held under the Education Department and the County Councils, as well as those under the Home Office for Under-Managers' Certificates. The book may also be of use to miners and other workmen who, although not studying for any examination, are desirous of obtaining theoretical knowledge of their work. The young student is advised to bear in mind the necessity for practical experience in the mine, and to visit collieries in order to see the different methods of carrying out the same kind of operations which are in vogue. The work includes selected exercises and a useful index. There are 200 illustrations. On page 9 we notice something about "ituminous" coal, which may puzzle the youthful student, though it will be less mysterious to the printer.

A Practical Treatise on Modern and Oil Engines. By Frederick Grover, A.M.Inst.C.E., M.I.Mech.E. Manchester: The Technical Publishing Co., Ltd. London: John Heywood, 5s. net.—Mr. Grover's treatise, which now occupies some 372 pages, replete with tables, diagrams, and illustrations, has the additional advantage in its third edition of chapters on gas engine efficiency and the application of entropy diagrams thereto. The author has also included his experiments on the explosion pressures of acetylene and air (previously published in pamphlet form), together with the results of tests. The general arrangement of a gas engine plant is first described, together with the various types of modern gas engines. The author then proceeds to explain how their leading dimensions may be calculated, and shows in detail the apparatus required and the calculations necessary to make a complete gas engine trial. In the second part of the book a brief description is given of the physical properties of oils, of oil-engine vaporisers, and a few special points in connection with oil-engine testing. A carefully compiled index to the subject matter greatly adds to the utility of the volume.

Notes on the Construction and Working of Pumps. By Edward C. R. Marks, A.M.Inst.C.E., M.I.Mech.E. Manchester: The Technical Publishing Co., Ltd. London: John Heywood. 3s 6d. net.—Purchasers of pumps will find a collection of information in this volume which may save them much trouble. The author first deals with matters common to all pumps, such as the conditions affecting the limit of suction lift, piston speeds, air vessels, pipes and other connections, types of valves, packings, etc. He then describes the leading types of pumps and pumping engines in the finished state, at the same time furnishing such particulars of construction and capabilities as are likely to be of use to manufacturers and others engaged in the difficult task of selecting the best available pump for a given kind of work. There are numerous illustrations and an index.

Rhodes's Steamship Guide to the Oversea Services of the World, 1902-1903. Geo. Philip and Son. 1s.—A handy *vade mecum* for travellers. Its Gazetteer of Ports, from Aalesund in Norway to the fortified seaport of Vigo, puts the prospective passenger on the track of all necessary information. For sailings, fares, and steamers available he can turn to the list of lines, and supplementary details are furnished alphabetically in the Directory of Mail Steamers. The work has numerous illustrations and plans. We also note some informing prolegomena. For instance, it is just as well for a passenger to know that he can be put ashore at the first port should the surgeon certify that he is suffering from a contagious disease, or has become insane. There is also a sharp, uncompromising paragraph about dogs :—

"Dogs, birds, or other animals are received only on special conditions, and in special circumstances. Dogs, when permitted on board, are usually handed over to the keeping of the ship's butcher."

Apparently, the steamship companies have a short way of dealing with undesirables and dogs, which can scarcely fail to redound to the comfort of the passengers as a whole. But we are tempted to inquire what the ship's butcher does with the dogs, and whether the man with the knife can be propitiated in this particular instance by the tactful application of backsheesh.

The concluding section of the Guide is devoted to Naval Construction.

Aids in Practical Geology. By Grenville A. J. Cole, M.R.I.A., F.G.S. With numerous illustrations. Fourth edition, revised. Charles Griffin and Co. Ltd. 10s. 6d.—This finely illustrated work, placed in the hands of the young student should inspire him with zeal to become a great geologist. The volume is a useful companion to the ordinary text-book and aims at assisting practical inquiries out of doors. Part I. is devoted to "The Sampling of the Earth's Crust," Part II. to "The Examination of Minerals," Part III. deals with "The Examination of Rocks," and the fourth and concluding section is devoted to "Fossils." The chapter which deals with blowpipe examination introduces the element of chemistry, and there is no student who has ever made a borax bead or studied characteristic reactions, but will find this portion of the work of exceptional interest. We are only doing ordinary justice to the new edition of these "Aids" when we say that it ought to be welcomed by everyone who aspires to wield the geological hammer to a purpose. In the present edition, attention is specially called to the applications of the microscope to powdered samples of rock and isolated minerals.

Directory of Americans Resident in London and Great Britain—American Firms and Agencies. Compiled and edited under the direction of W. B. Bancroft. Sold by Eden Fisher and Co., Ltd. 5s. net.—We are pleased to see that the scope of this unique publication has been enlarged this year, and that it furnishes, besides a more complete list of Americans resident in London, a fairly extensive record of our transatlantic cousins domiciled permanently or temporarily in other parts of the United Kingdom.

An article on "American Engineering in Great Britain" will be read with interest, and if we on our part choose to take some of the remarks therein *cum grano salis*, allowances must be made for our insular prejudice, or shall we say for the buoyant enthusiasm of Brother Jonathan.

Calculations in Hydraulic Engineering. A practical text-book for the use of students, draughtsmen, and engineers, with numerous illustrations and examples. By T. Claxton Fidler, M.Inst.C.E. Part II. Longman's "Civil Engineering Series." Longmans, Green and Co. 7s. 6d.—This volume, covering calculations relating to the motion of water and to the construction of works intended for its conveyance, is designed to meet the actual requirements of the hydraulic engineer in his daily practice, and is a continuation of the work of which publication was commenced in 1898. Part I. deals with Fluid Pressure and the calculation of its effects in engineering structures, the published price being 6s. 6d. The work is illustrated by numerous diagrams. The author shows a thorough grasp of his subject and the two volumes are eloquent of "an infinite capacity for taking pains."

Assaying and Metallurgical Analysis for the Use of Students, Chemists, and Assayers. By E. L. Rhead and A. Humboldt Sexton, F.I.C., F.C.S. Longmans, Green and Co. 10s. 6d. net.—A handbook which is intended to include the greater part of the work likely to be required in the laboratory or assay office. Part I. is devoted to laboratory appliances and general processes, useful hints, rather than full descriptions, being given. In Part II. the general plan followed has been to consider, under the name of each metal, (1) the materials and products in which its estimation is commonly required, giving a brief description of their characters, so as to make identification easy ; (2) the dry tests for and important chemical relations of the metal, with, in some cases, special instructions for the detection of small quantities ; (3) the methods of conducting the dry assay by fusion or otherwise, followed by applications to special materials where modifications are necessary ; (4) methods of dissolving substances and preparing solutions for the determination of the metal ; (5) methods for the gravimetric, volumetric and colorimetric determination, with the precautions necessary. In Part III.—Metallurgical Analysis—an attempt is made to group the very various substances to be dealt with in a compact manner, and, by cross references inserted in the text, to, as far as possible, avoid repetition. Altogether an excellent work, complete in its inception, and carefully elaborated in detail, with full regard to the value of conciseness and simplicity of arrangement. It should be in the hands of every assayer.

An Elementary Treatise on Alternating Currents. By W. G. Rhodes, M.Sc. (Vict.). Longmans, Green and Co. 7s. 6d. net.—In this text-book the author has made a special effort to eliminate mathematical difficulties, and presents the subject in suitable form for practical engineers, University honours students, and the more advanced students in technical schools studying for the Honours Grade in Electric Lighting for examinations of the City and Guilds of London Institute. It is emphasised that a short course of vector algebra should form part of the curriculum of every University college and technical institute.

Civil Engineering as applied in Construction. By Leveson Francis Vernon-Harcourt, M.A., M.Inst. C.E. Longmans, Green and Co. 14s. net.—This thoroughly practical addition to Longman's "Civil Engineering Series," bears upon it the stamp of sustained labour, well trained observation, and careful discrimination in the selection of matter. Indeed, the extent and variety of practice that the author has been able to compress within the covers of a single volume is little short of remarkable, and in view of the magnitude of the task undertaken, it is not difficult to understand that he has at times been tempted to despair of bringing it to a satisfactory issue. Delay in publication has, however, had undoubted advantages, for the author has been able thereby to introduce a great deal of valuable information culled during his travels on the Continent and elsewhere. He is to be congratulated on the successful accomplishment of a work involving exceptional difficulties. Part I. deals with materials, preliminary works, foundations, and roads; Part II., with railway, bridge, and tunnel engineering; and Part III., with river and canal engineering and irrigation works. The two remaining sections cover dock works, and maritime and sanitary engineering. Obvious care has been bestowed upon the very numerous illustrations in the text, and an admirable index, giving not only the page numbers of subjects dealt with, but also subsidiary headings, places every part of the volume at the immediate disposal of those who use it as a work of reference. The publication is replete with interest, and presents a comprehensive survey which will be found of exceptional utility.

Deschanel's Natural Philosopy. Part III.—Electricity. An expansion of Everett's Deschanel, Part III., on the lines of Modern Electrical Theory. By J. D. Everett, M.A., D.C.L., F.R.S. Blackie and Son. 4s. 6d.—In this work, which is in the main new, Professor Everett caters for those who desire an up-to-date knowledge of electricity without the burden of deep mathematical research. Fundamental principles are stated clearly, and in the deduction of consequences much attention has been given to selecting and devising the simplest proofs. A full explanation of Maxwell's conceptions with regard to electric action in Dielectrics, has been included, and electro-magnectic induction, as being the principle lying at the root of all electric supply on a large scale, has two long chapters. The chapters on dynamos and electro-motors have been brought into line with the most recent theories, and in connection with magnetism a full summary is given of Ewing's methods of testing iron, with results. For the benefit of advanced students, a new chapter is introduced describing several special methods of electrical measurements which have assumed practical importance, and a number of other features have been added with a view to the presentation of the subject in its modern shape as a clear and connected whole. The book is published in extremely useful form, and is furnished with a series of examples and answers.

Easy Mathematical Problem Papers. By Charles Davison, Sc.D. Blackie and Son, Ltd. 2s. 6d.—These papers, by the mathematical master at King Edward's High School, Birmingham, form a course for pupils about the age of seventeen, and include problem papers and miscellaneous problems in arithmetic, algebra, geometry, and trigonometry. The book can be had with or without answers and hints for solution.

Our Empire Under Protection and Free Trade. By Sir Guilford L. Molesworth, K.C.I.E. Ward, Lock and Co. 1s.—In view of the present controversy on the subject of Protection and the heart-burnings occasioned by the latest Budget, this scathing condemnation of Free Trade makes a timely arrival. It is argued that England acquired her commercial and industrial superiority under a policy of strict Protection, and that by this same policy she is now being supplanted by the United States and other Protectionist nations. The great prosperity which gained Free Trade its prestige is attributed to a general wave of prosperity and improvements throughout the world which has been shared by other nations of late years in a far greater degree than by us.

"Free Trade, so called, has had a patient trial of more than half a century, and it is now time to take stock of the results in order to see how we stand. The results may be briefly summed up as follows: Under our policy of Free Trade we have lost that commercial and industrial superiority which we acquired under the policy of strict Protection. Our policy of direct taxation bears heavily upon our industries, and reacts on the working classes in reduction of wages and employment. Our agriculture has been ruined, and our industries are struggling hard for existence. Other nations, under a policy of strict Protection, are beating us in the race of competition, not only in neutral, but in our own markets. The policy of Free Trade has not secured for us either the cheap loaf, low prices of provisions, or reduced cost of living, for all of these have been equally secured by nations under a strict protective policy. We have sacrificed the substance for the shadow."

"The American competition is far more formidable than that of Germany," he remarks, "for her protective policy is far more complete."

"If America had pursued the policy of free imports, she could never have developed her manufactures. She would have remained a huge agricultural country, exchanging her agricultural produce for our manufactures; even as it is, she experienced the greatest difficulty in developing her resources. Whenever she attempted to start an industry the English manufacturers killed it by dumping down upon her a quantity of materials at low prices, and again raising the price as soon as the industry had been ruined. It was only by imposing high tariffs that industries could be developed. This was specially the case with the iron, steel, and tinplate industries. In

1846 iron rails were sold in the United States at 50 dols. per ton, but as soon as the tariff was removed English manufacturers reduced the prices of rails to 40 dols., swamped the market, then, after having ruined the industry in the United States, they raised the price to 75 dols.

"In 1867 steel rails were sold in the United States for 150 dols. per ton, but under a heavy tariff the steel rail industry was established in the United States, and in 1883 the price had fallen to 40 dols. Sir Lyon Playfair, as the apologist for the Cobden Club, has endeavoured to account for the fall by improved processes of manufacture, which, of course, had some slight share in it, but the only improvement that would very materially cheapen the cost of steel rails is the 'Bessemer' process, which was invented as early as 1855, and was in full use long before the dates above mentioned. The reduction of price is fully accounted for by the fact that between 1868 and 1899 the output of steel rails in the United States increased from 8,618 tons to 2,270,000 tons. The output of the United Kingdom decreased from 1,019,000 tons in 1890 to 838,000 tons in 1899."

In the earlier pages of the work the author urges that a great opportunity is now afforded for commercial union between England and her colonies.

Cassell's Cyclopædia of Mechanics. Containing Receipts, Processes, and Memoranda for Workshop Use. With 1,250 illustrations and an index of 9,250 items. Edited by Paul N. Hasluck. Second series. Cassell and Co., Ltd.—This substantial volume of 384 pages includes a vast quantity of information on many subjects, compiled from articles which have appeared in *Work* and the *Building World*. Indeed, so wide is the range of subject that the title appears to us to be somewhat of a misnomer. For instance, to take the first twenty or thirty pages, it is a far cry from an electric engraving machine to the preparation of "a polish for glacé boots, to be applied with a sponge." Nor is it quite apparent what this or the "breaking of violin strings" has to do with mechanics or the workshop.

There is no doubt considerable difficulty in arranging paragraphs of this description in an organised sequence, but the excellent index notwithstanding, we imagine that any plan would be better than none. For instance, at page 21 we read all about "Heating water for bath." At page 25 we arrive at another paragraph, "Heating bath water." It is a relief on turning to the index to find these and nearly a score of other items about baths brought together in one place. The index saves the situation, but we certainly think an improved classification of the paragraphs might be made, though from the prefatory note we gather that this has not hitherto been found possible.

The Cyclopædia is unquestionably a very useful and valuable work, either for purposes of reference or for general reading, and we imagine that there are few mechanics or people with aptitude and constructiveness who could turn over its pages without finding something of interest, and possibly an impetus towards new fields to conquer. A great number of excellent diagrams and illustrations add to the utility and attractiveness of the volume.

The Steam Turbine. By Robert M. Neilson, A.M.I.Mech.E. Longmans, Green and Co. 7s. 6d. net.—A volume which should be in the hands of all who are following up the development of the steam turbine. The author describes not only the principal parts of the leading types, but also the small details which are necessary to effective construction. He enters fully into the theory of the action of the steam turbine, and deals with the subject historically. An appendix sets forth the various patents which have, from time to time, been obtained. The work has some fine half-tone engravings, and is profusely illustrated throughout by line illustrations.

The United Kingdom and Its Trade. By Harold Cox. Harper and Brothers. 3s. 6d.—This handy volume, packed with statistics and up-to-date information, is the first of Harper's International Commerce Series, the object of which is two-fold. In the first place, it is to supply, in a compact form, to managers, clerks, and agents of commercial firms in all parts of the globe, accurate information about the commerce, resources, and needs of the principal countries of the world; the second, and equally important purpose of the series, is to supply to teachers and students in technical schools, colleges, and commercial universities throughout the British Empire and the United States of America, what we may perhaps call guide-books to the wealth of modern nations. We see in this series a very praiseworthy enterprise, which promises to be well carried out. It is certain that in order to leave nothing undone to maintain the prestige of British commerce we must be thoroughly alive to the progress made by other nations. In the course of his researches Mr. Cox has come to the remarkable conclusion that "there is no man in the Kingdom who can say what is the real total of the expenditure controlled or the revenue raised by the direct authority of Parliament."

United States and its Trade. By Henry Loomis Nelson. Harper and Bros. 3s. 6d.—Another of the above excellent series, this volume makes a valuable addition to the reference library. Speaking of trusts the writer says:—

"The trust is regarded by some as the ultimate solution of an economic problem, but it has yet to vindicate itself and prove itself to be the highest type of administrative efficiency. In its early stages, which are not yet passed, it is subject to ills not unknown, at the outset, by the earliest forms of the corporation. It is often capitalized at more than its value, and it therefore deceives the investing public. Reduction of capital and reorganization are sure to come in some of the largest enterprises. The trust invites legal interference by reason of the frauds which have been practised before the public in its name, and because it is suspected of corrupting legislative bodies. Still, when it passes the present period, if only it can survive the hostility of labour, it is likely to become a great conserver of energy and preventer of waste. Organized labour is in doubt about the trust; but, as a matter of fact, organized labour, itself a trust, is now dealing with organized capital, and thus far the result has not been harmful to the wage-earners."

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention PAGE'S MAGAZINE when you write. Manufacturers of Engineering and Electrical Specialities, etc., etc., are invited to forward for review in this column copies of their catalogues, price lists, and circulars, as soon as issued.

The Avonside Engine Co., Bristol.—We have received, just in time for notice in this issue, a well-designed little booklet (Catalogue A) in which are portrayed to advantage some of their most recent types of locomotives for narrow-gauge railways "in stock or progress," including the "Lyell" (cyls. 10in. to 18in. dia.), the "India" (cyls. 10in. to 18in, dia.), the "Fechan," "Weston," "Imperial," "Spain," "Tangier," "Bengal," "Inglesa," "Britain," "Somerset," etc. On page 11 appears a series of sectional diagrams of buffer and draw gear, which should materially assist prospective buyers when particularising their requirements in this direction.

The Campbell Gas Engine Co., Ltd., Halifax.—This firm have recently added some new sections to their already bulky catalogue. Section A has nearly twenty illustrations of their latest designs in oil engines, suitable for ordinary power purposes and for electric lighting plants, together with particulars of their special type of self-starting apparatus for large engines. Section B embodies a description of their small combined pumping plants. Sections C and D are similarly arranged pamphlets, showing their oil engines as applied to winding and hauling gears and air-compressors. In section E their standard designs of mining pumps for moderate and high lifts are shown, as well as special types for water supplies and for pumping sewage, etc.

Chas. Winn and Co., Birmingham.—A new catalogue and price list of their principal manufactures, comprising screwing machines, fitters' tools, and steam fittings. Within the last few months several new features have been introduced in screwing machines, and, in addition to various mechanical improvements (of which the duplex vise is an important one), it has been possible to considerably improve the appearance of these machines. Specimen steam fittings, selected from an extensive range of modern boiler and engine mountings, are illustrated by half-tone and line engravings, and include their parallel slide stop valves, in which important improvements have been made. We also note some interesting details of their patent "Reliable" gauge-glass protector, the excellent qualities of which are vouched for by the good opinion of the various railway companies.

The Auto Machinery Co., Ltd., Coventry.—A series of descriptive pamphlets and price lists covering the manufacture of goods from hard cast steel, ground to very fine limits. One of their principal specialities is a ball thrust bearing made of the best cast steel, hardened, tempered, and accurately ground. The bearing is correctly designed for running with the least possible friction, and is adapted to loads of from 618 to 8,043 lbs. per ball at speeds of from 10 to 1,000 revolutions per minute. Special designs of ball can be submitted to meet *any* conditions of load and speed. Other manufactures are "The Auto" gun-metal valveless circulating pump for motor cars, etc. ; the "Auto" roller bearing—well known as an oil and power saver when applied to motor cars, tramcars, etc., etc. ; "Auto" ball thrust rings—for which special advantages are claimed—nuts, screws, bolts, studs, bright washers, and all kinds of steel, phosphor bronze, manganese bronze, and brass balls.

The Library Bureau, Ltd., London.—We have received a very interesting and well-arranged booklet of 60 pages and cover, printed in two colours—entitled, "Vertical Filing." Although not an engineering firm in the ordinary sense, we gather from their own description that they have successfully engineered to a satisfactory solution a most important problem, viz. : How to turn the old-fashioned complicated method of filing correspondence, catalogues, credit reports, invoices, orders and duplicate bills, requisitions, legal documents, and the multiplicity of other office papers into a simple, automatic, and expansive system. Library Bureau methods make an end of congested records, and convert confusion and chaos into simplicity and order. The system is described at length, and the booklet should be read by everyone who has to deal with the filing of correspondence. The letters are filed numerically in a vertical filing cabinet, an alphabetical card index supplying the necessary reference numbers.

The Lyle Co., Ltd., London.—Another filing system for which the promoters claim exceptional advantages, is that of the Lyle Co., Ltd., the principal factor in this case also being a simple and easy method of card indexing. Letters and papers, no matter in how great variety, can be found quickly when wanted, and the system "is sufficiently elastic for the most complex correspondence." Among the "abilities" of which we are told the system is capable, are: accessibility, expansibility, adaptability, divisibility, contractibility, up-to-date-ability, and in a neat little brochure, tastefully arranged, we are informed that the "Lyle" Card Index System is already in use in the offices of almost every trade or profession. A card ledger is another of the company's specialities. Each account has a card ruled both sides, which is good until filled, when it is eliminated and placed on the transfer file, whither all closed accounts are at once removed, so that only open accounts need be handled.

Ernest Scott and Mountain, Ltd., Newcastle-on-Tyne.—Circular 27 has just come to hand, and we cannot speak too highly of its general appearance and get up. It is an exquisitely printed brochure of about 70 pages, profusely illustrated by half-tone blocks of the first quality. Various electric lighting, power, pumping, and hauling plants recently supplied by the firm are described, the object being to introduce to the readers' notice some of the latest types of machinery for electrical transmission under various circumstances. Accompanying the booklet is an excellent little pamphlet (illustrated) containing a short but interesting article on the Utilisation of Electrical Machinery in Coal and other Mining, by W. C. Mountain. Of interest to all users of electrical power.

The Pressed Steel Car Co., Pittsburg, Pa.—A "Catalogue de luxe" of 77 pages and cover, printed in two colours, on the best art paper and illustrated by large half-tone blocks. The whole catalogue from beginning to end is quite a work of art and reflects much credit on its designers. An edition is also published in French. Their different makes of pressed steel cars are well described, and the illustrations include one or two of exceptional interest, being reproductions from photographs of railroad accidents in which the pressed steel cars certainly appear to have withstood the shock of the collisions much better than their wooden companions; in fact, they are scarcely damaged, while the others figure as a hopeless pile of wreckage. In addition to the ordinary pressed steel cars the company manufacture various kinds of pedestal trucks from the same material for 60,000, 80,000, and 100,000 lbs. capacity cars and tenders.

The Newall Engineering Co., Ltd., London. A short treatise on "Limits and Limit Gauges," which are specially manufactured by this firm with a guarantee of accuracy to ·0001. Particular mention is made of their caliper limit gauge, which it is claimed supplies a full stock of solid limit gauges at once. The frame is in the form of a crescent, and is made of special metal for the purpose. The screws and anvils are of hardened steel, ground true after hardening, and the holes for them are put in on a special machine, which ensures their being in line. It is claimed that the locking plugs, when closed, make the gauge fully as rigid as a solid one. The use of the gauge is obvious.

T. S. McInnes and Co., Ltd., Glasgow.—Two illustrated pamphlets, one being a description of the "Mathot" Continuous Explosion and Pressure Recorder, and the other a treatise on Messenger's Furnace Deformation Indicator (Patented) for gauging the circularity of boiler furnaces and cylinders. The pressure recorder is an instrument for registering the variations in the explosions of gas and oil engines, and the strokes of pumps, compressors, etc. As illustrated, the instrument is fixed to a McInnes-Dobbie gas engine; the text informs us that it gives a continuous graphic tracing, from which the number of explosions, together with the initial pressure of each, can be determined. It also shows the regularity (or otherwise) of the variations, and the corresponding number of revolutions, proportion of misses, rate of compression, etc. The Deformation Indicator is also a very useful instrument which, by a simple process, indicates the slightest distortion in the circularity of a furnace. One or two letters (reproduced) from users speak highly of its capabilities and general utility.

Sheppard and Sons, Ltd., Bridgend. — A well-printed and freely illustrated booklet descriptive of their coal-sizing, washing, and colliery plant, coal-breaking and crushing machinery, elevators, conveyors, etc. Special attention is called to the "Sheppard" improved coal-washing machine, which, it is claimed, is the most effective form of washer for purposes where it is undesirable to size the coal previous to washing. Over 100 such plants have been erected at home and abroad. A couple of line engravings illustrate the longitudinal section and ground plan of the Cyfarthfa Washery, which is capable of dealing effectively with 500 tons per day. A screening and loading plant manufactured by the firm is also of interest to colliery proprietors, mining engineers, etc., and their patent portable railway engines are well worthy of notice.

W. F. Mason, Ltd., Manchester.—Judging from the long list of names of well-known firms both at home and abroad who are users of Duff's Patent Continuous Gas Producer (according to the pamphlets which have reached us), there is little doubt that this extremely useful though simple device continues to command much favour. Its manufacture and use are very lucidly described in a well-written booklet of 50 pages by

F. J. Rowan, A.M.I.C.E., Glasgow, published by the makers. Other specialities of this firm are the "Weardale" Furnace and the Duff Patent "Continuous" Forced Blast Furnace—the latter of which, we are told, marks the latest improvements for burning low grade fuels, and embraces many advantages non-existent in other furnaces.

Henry Crowther, Cleckheaton.—A well designed and useful catalogue and price list of wrought-iron pulleys shafting, etc., for the transmission of power. The booklet contains some excellent reproductions from photographs of the principal specialities manufactured by the firm, including steel shafting, loose collars, couplings of many descriptions, clutch levers, plumber blocks, pillar and wall brackets, sling hangers, etc., etc., of interest to users of all kinds of power machinery.

J. H. Holmes and Co., Ltd., Newcastle-on-Tyne.—A tastefully arranged and well-printed brochure, profusely illustrated with half-tone reproductions of their principal speciality, the "Lundell" continuous current and electric motors, as applied to ventilating fans, newspaper printing, paper cutters, ruling machines, notching, punch and die presses, pressure blowers, travelling cranes, boring and drilling machines, etc. The application of these motors for driving newspaper machines is quite a new development, but that it is already becoming popular is shown by the long list of journals using the system.

W. T. Glover and Co., Ltd., Manchester.—A well-printed illustrated booklet of 20 pages and cover, containing price list for telegraph, telephone, and electric bell wire, telegraphic and telephonic cables, etc. The principal specialities of the firm are patent telephone cables (single and metallic circuits), twin "Magpie" cable (metallic circuit), and an improved anti-induction telephone cable for both single and metallic circuits. Lightning conductors, a new wire gauge, and a patent cable suspender are also specialities.

British Thomson-Houston Co., Ltd., London.—The latest addition to this firm's ever-increasing catalogue of new electrical appliances is an eight page pamphlet (No. 125), descriptive of a new traction motor, which has been designed to meet the demand for motors correspondingly larger than those heretofore used for tramway work owing to the tendency to increase the sizes and speeds of cars. It is called the G.E.—67 Traction Motor, and is of greater capacity than the well-known G.E.—52, while combining in a remarkable degree light weight, compactness, and efficiency. Accompanying the pamphlet is a printed index to the whole of the catalogue, printed up to May 15th, 1902. This is a very useful and welcome addition. A very neat illustrated brochure of eight pages and cover sets forth some of the advantages claimed for the B.T.H. Edison incandescent lamp. It is pointed out that each of these lamps undergoes fifty constructive operations, and has forty separate tests performed on it before it is completed. The pamphlet also gives a useful lesson on the economic use of electric bulbs.

Ed. Bennis and Co., Ltd., Bolton.—An illustrated booklet of sixteen pages explaining the mode of applying the Bennis patent pneumatic geared machine stoker and self-cleaning compressed air furnace, of which they state there are now over 12,000 in use. Their automatic steam regulator is also described and illustrated. The booklet is supplemented by two four-page pamphlets—one being the reprint of an article from *The Paper Maker and British Paper Trade Journal* of the 16th September last (in which the Bennis system is favourably expounded), and the other containing a table of good results from comparative tests. A letter (reproduced) from one of their customers portrays in glowing terms the exceptional advantages accruing from the use of the Bennis patent mechanical stoker.

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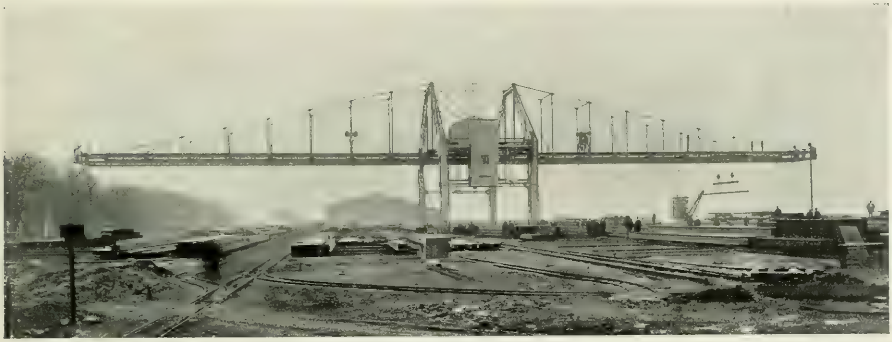

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For Stocking and Loading Material. Span: 325 ft.

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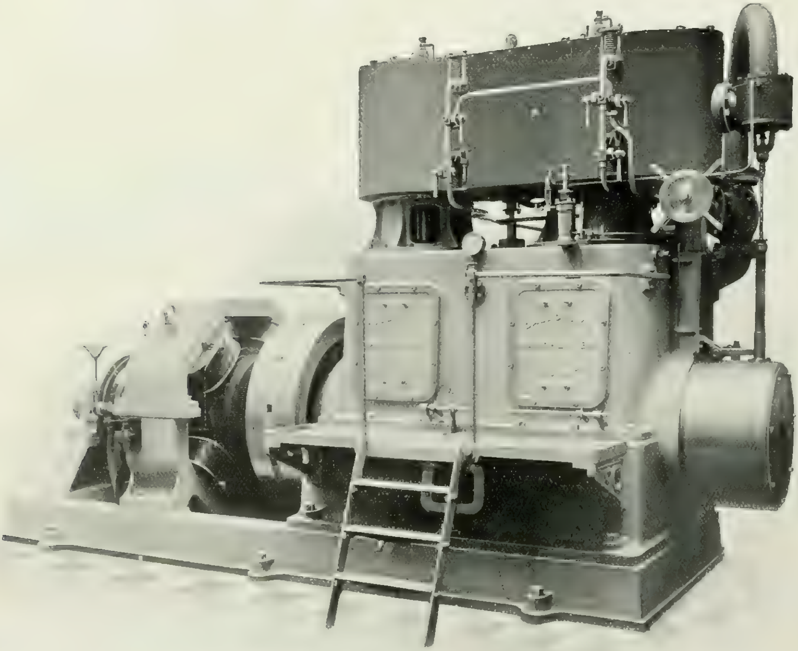

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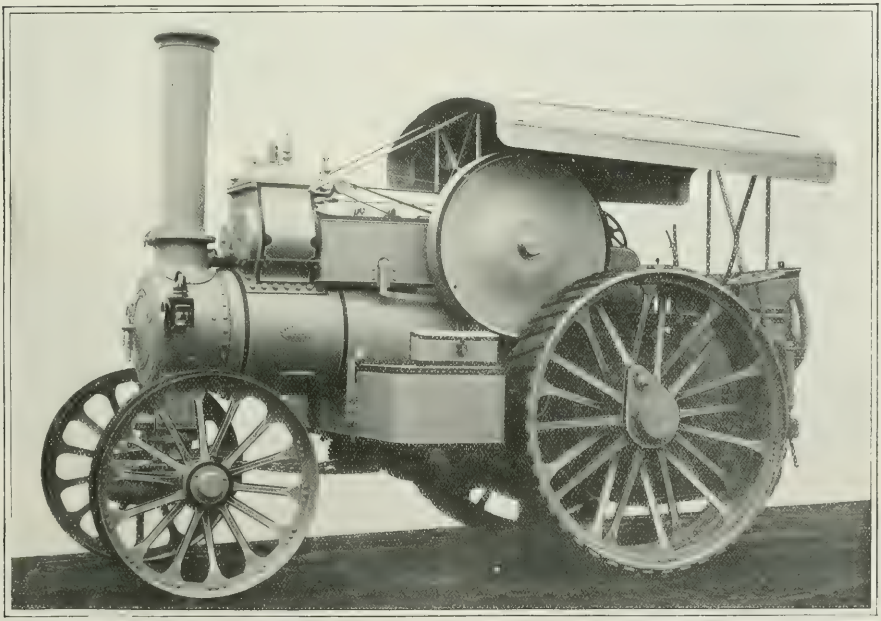

Fowler's Road Locomotive. Designed for all kinds of Steam Haulage, and is also available for temporary belt driving. Three sizes of this Engine are standardized, and employed approximately for 20, 30, and 40 ton loads. A special heavy Engine is also made equal to a load of 50 tons, and called the "Lion" type. The Engine was thus named by the War Office Authorities, who are employing a number of them in the South African Campaign.

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Contractors to His Majesty's Government, The Crown Agents for the Colonies, Agent-General for the Cape, Public Works Department of Ireland, etc., etc. Manufacturers of Tank Engines of all descriptions, suitable for Contractors, Collieries, Iron Works, Quarries, Docks, Sugar Plantations, Tramways ; Light, Narrow Gauge and Short Branch Railways, or Lightly Constructed Colonial Lines.

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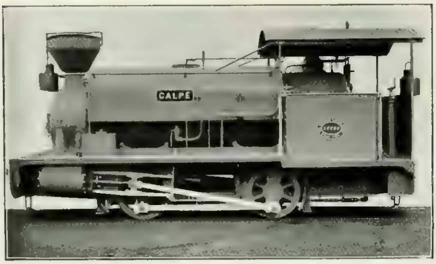
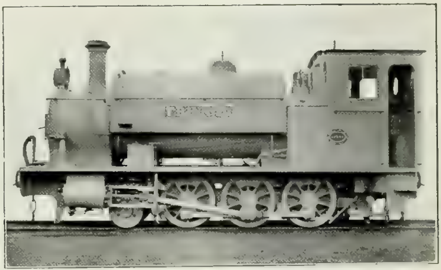


Cyls. 10in. X 16in. Gauge 3ft. 3⅜in



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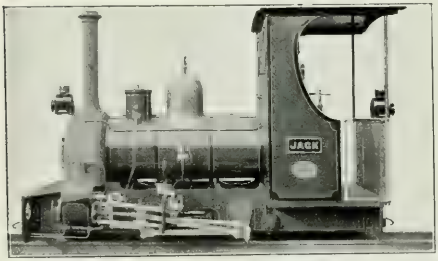
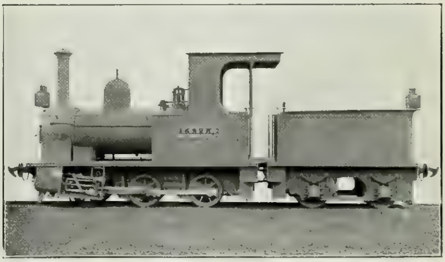
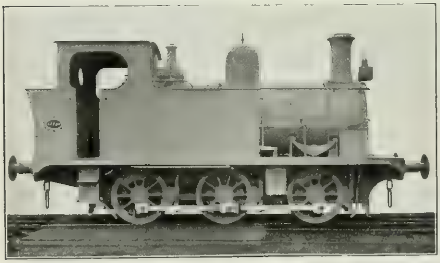


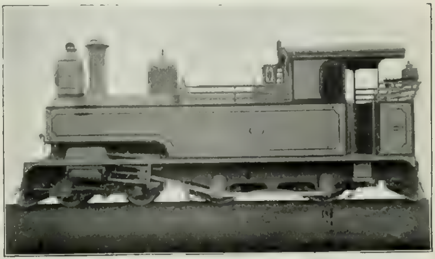
Cyls 6in. X 8in. Gauge 1ft. 6in.



Cyls. 8in. X 12in. Gauge 2ft 5¼in



Cyls. 15½in. X 20in. Gauge 4ft. 8½in.



Cyls. 11½in X 18in. Gauge 2ft. 6in.

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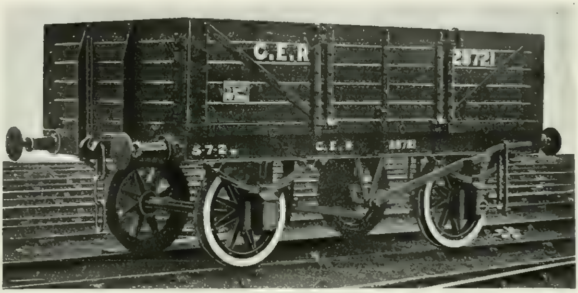

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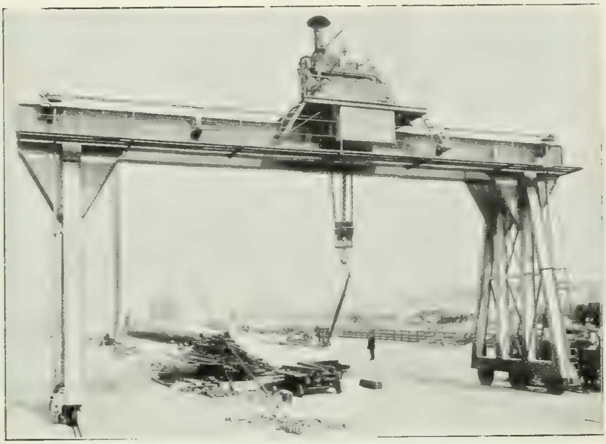

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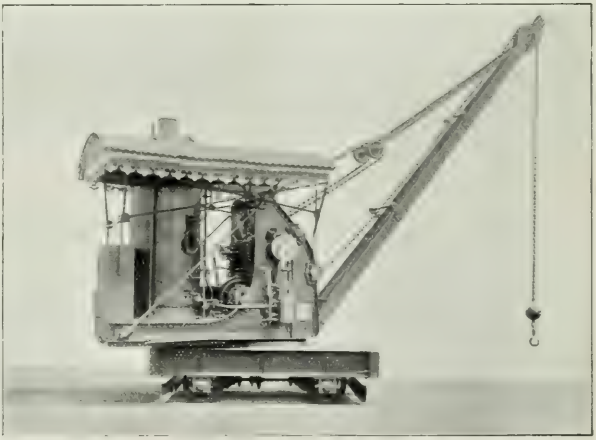

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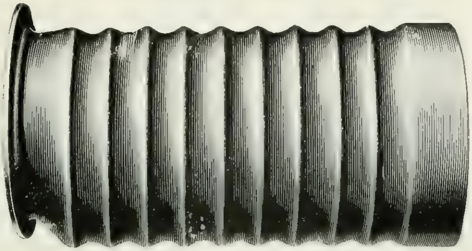

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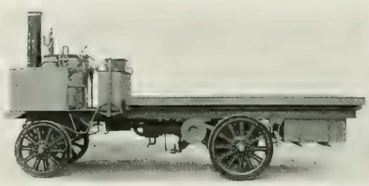

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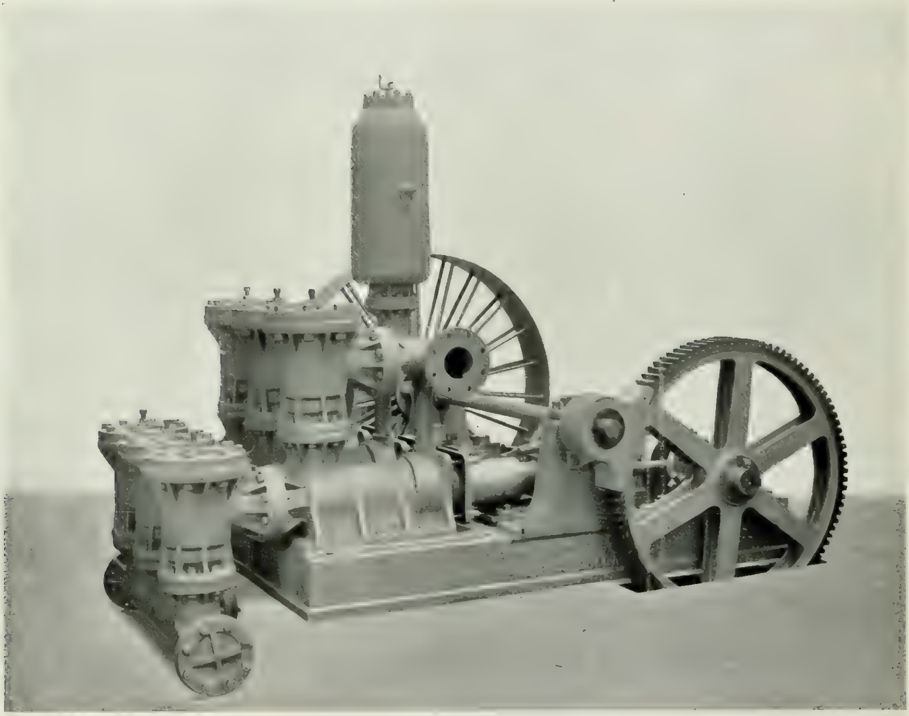

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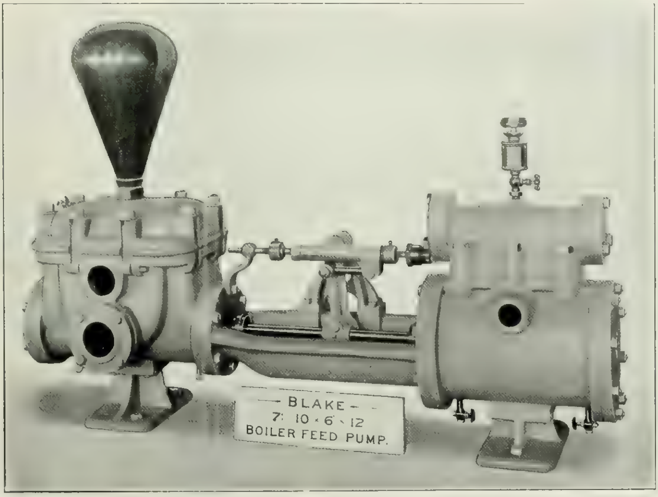

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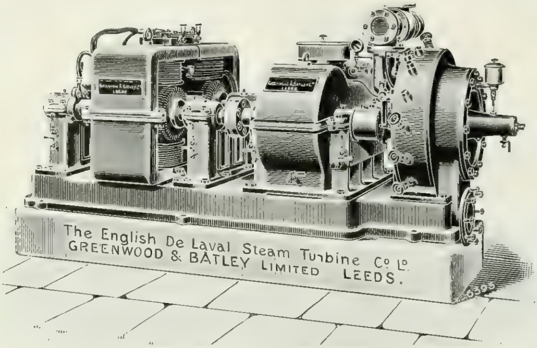
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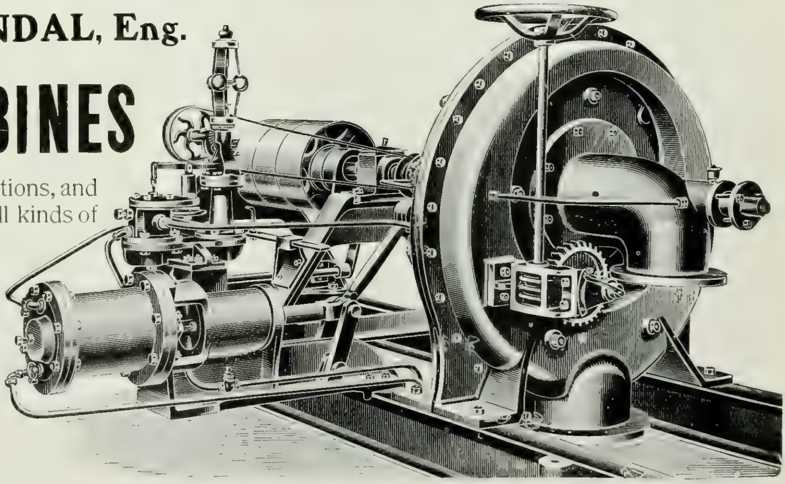

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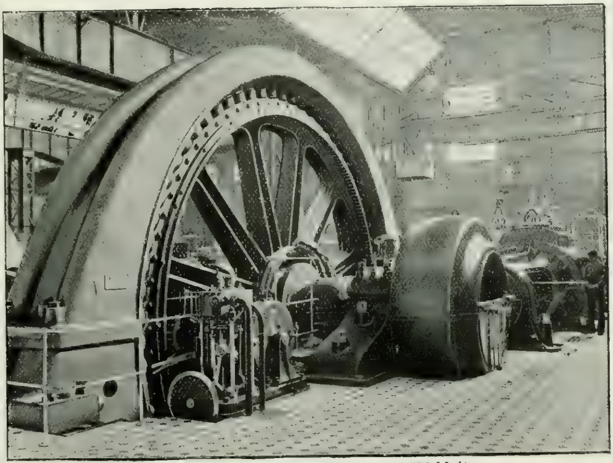

3000 Kw.-Three-Phase-Dynamo, 6000 Volt

Continuous Current ☆ Threephase Current

Electric Lighting Plants. Electric Transmission of Power.
Electric Railways and Tramways. Electric Central Stations.
Electro-chemical Plants.

Agencies throughout the World

Yearly Output 12 000 Dynamos and Motors equal to 170 000 000 Watts
10 000 000 Incandescent Lamps.

XI. 29

Awarded at the Paris Exhibition 1900: 6 Grands Prix.

International Electrical Engineering Co.,

We have supplied Car Equipments to GLASGOW, LIEGE, BRUSSELS, HERSTAL, BUCHAREST, etc. Also 100 Horse Power Railway Motors to BELGIAN STATE RAILWAY . . . . .

Clun House,
Surrey Street, Strand,
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Chief Works : LIEGE.

Branches :
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Our Factory is organized and run on the very latest American lines, with Swiss, English and German Designers.

Contracts in hand for the municipalities of Glasgow, Hull, Bray, Dundee, Bristol, Colne, Bloemfontein, Erith, etc., besides very many private firms.

All Bolts, Nuts, Screws, etc., to Standard Whitworth Gauge.

General Director :
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Technical Director and Manager :
Mr. G. J. MELMS,
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Mr. E. KILBURN SCOTT,
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Telegrams :
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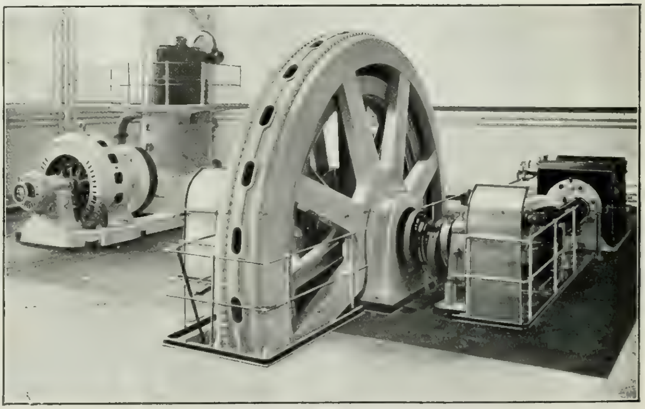
We have supplied Electrical Plant to more Iron and Steel and large Engineering works in U.K., Russia, and Belgium than any other firm . . . .

SEND FOR PRICE LISTS.
The Most Complete in the Trade.



Three-phase Alternators for Transmission of Power in Manufacturing Works.

THE

Wheeler Condenser

AND

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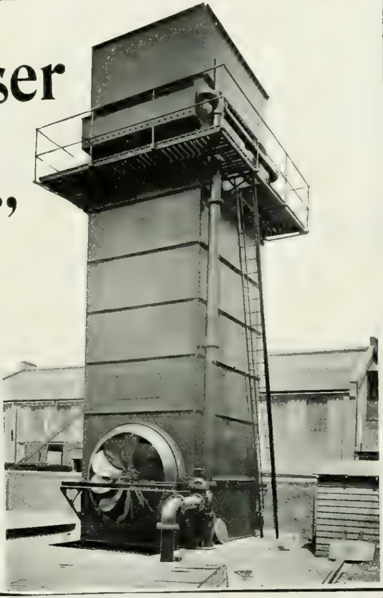

The most compact, durable, and efficient Cooling Tower Manufactured.

Maximum reduction with minimum loss by evaporation.

90,000 h.p. operating in Great Britain.
25,000 h.p. in process of construction.

CONTRACTOR TO H.M. GOVERNMENT.

For . . .

MINERALS, ARTESIAN WELLS, &c.

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The St. Helens Cable Co., LIMITED,
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SOLE MANUFACTURERS OF

Dia's Waterproof Paper Cable

THE ONLY SUCCESSFUL ONE YET PRODUCED.

Laying Dia's Impregnable Paper Cables on Westminster Bridge.

No Central Station should be without Dialite Mats, or Dia's Patent Safety Glove, for Electricians, tested with 5,000 v. before leaving the works.

The Manager of the Liverpool Overhead Railway writes :
". . . the most effective for practical purposes on the market."

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Süddeutsche Kabelwerke A.-G., Mannheim-Neckarau,

(SYSTEM BERTHOUD BOREL.) GERMANY.

Contractors to the Imperial German Postal Authorities.

TELEPHONE CABLES

With Paper and Air Insulation.

LEAD-COVERED CABLES
For all Tensions up to 40,000 volts.

SILK-COVERED COPPER WIRES.

The

Scotch & Irish Oxygen Co., Ltd.,

ROSEHILL WORKS, GLASGOW.

Valves for Gas Bottles, and Aerated Water Drums in Bronze, Steel, and Aluminium.

Reducing Valves, Keys, and all Fittings for Compressed Gases.

J. HALDEN & Co.,

8, ALBERT SQUARE,
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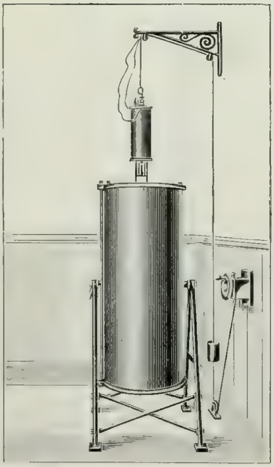

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Arc Lamp Duplex Radial

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(SHAW AND HALDEN PATENT).

Frame, Copying Two Tracings, 53 × 31, in Two Minutes, complete with Lamp, &c.	£45 10 0
Light Frame, for Architects, 40 × 27, complete	25 0 0

Now on view, Stand 39, Industrial Section, Wolverhampton Exhibition.

ADVANTAGES OF DUPLEX RADIAL PHOTO-COPYING FRAME.

A. Copying indoors at any time where Electric Current is available.
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E.—Two full size Tracings can be copied at one operation.
F. The glass plates can be very easily cleaned when Frame is horizontal.

Also at London, Newcastle-on-Tyne, and Birmingham.

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On
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MAKERS OF **High=Class**

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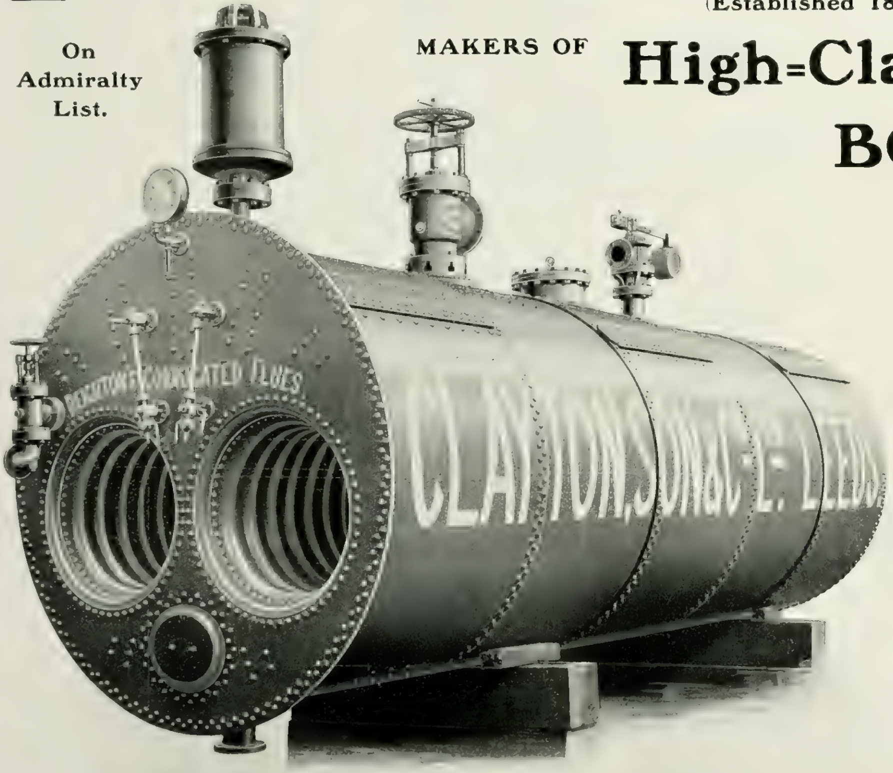

To stand any test or pass any inspection.

MADE BY THE
**Latest
Improved
Machinery.**

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**MOST MODERN AND
COMPLETE PLANT
IN YORKSHIRE.**

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Vertical Boilers

Always in stock
and in progress.

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SPECIALITY.—Boilers fitted with Deighton's Patent Corrugated Flues give 20 per cent. increased heating surface over ordinary flues.

Contractors for **ROOFS and all kinds of STRUCTURAL IRON and STEEL WORK.**

"PAGE'S MAGAZINE" FROM AN ADVERTISER'S STANDPOINT.

A few extracts from some of the letters received from firms advertising in the first number.

William Firth, Ltd., Iron and Steel Merchants, Leeds, write: We consider your Magazine completely puts in the shade the American and other similar publications professing to cover the same ground. The show of advertisements is magnificent.

The British Westinghouse Electric and Manufacturing Co., Ltd.: Please accept our congratulations. It always gives us pleasure to recognise push and well-directed energy, which leads to success. We like the appearance of your advertising pages; such co-operation between publisher and advertiser cannot fail to work to mutual advantage.

F. W. Schafer, Esq., Managing Director of **The Shannon, Ltd.,** Ropemaker Street, E.C., writes: I have read your Magazine with real pleasure. Its contents are so comprehensive and instructive, and cover so wide a ground, that if you keep up the character of the work you are bound to succeed. You deserve the highest credit for this useful production, and I wish you success.

W. G. Campbell, Esq., of the **Hunslet Engine Co.,** Leeds, in a letter to the Editor, says: I must certainly give you my heartiest congratulations for the splendid piece of work you have turned out; printing, paper, and illustrations are all that could be desired, and far ahead of what one is used to receive from the great number of engineering papers now running.

W. F. Mason, Ltd., Engineers and Contractors, Manchester, say: The matter and the manner of its display are alike excellent, and the handling of the advertisements in the interest of your clients leaves nothing to be desired.

W. Summerscales and Sons, Ltd., Engineers, Phœnix Foundry, Keighley, state: We certainly congratulate you upon the general "get up" of the Magazine, which looks exceedingly well.

Clayton, Son and Co., Ltd., Gas Engineers and Boiler Makers, Hunslet, Leeds: We have nothing but praise to bestow on your first number. It appears to us to be the best of its class.

C. W. Burton, Griffiths, and Co., Ludgate Square, Ludgate Hill, London, E.C.: We are surprised to find so many eminent authors and well-known men contributing to the Magazine, and we are sure it does you very great credit. We also notice that the advertisements are very striking, and tastefully got up.

The Library Bureau, Ltd., Bloomsbury Street, London, W.C., write: We have much pleasure in putting on record our entire approval of the turn-out and appearance of the Magazine, and think it quite reaches the standard, necessarily a high one, which such a magazine should aim at. We also consider the literary matter extremely interesting, and suitable for such a journal.

The British Steam Specialities, Ltd., Leicester, say: The issue is characterised by remarkable force. It claims an eminent position, and assumes it by sheer strength. To bring out such a work, ranging so widely in interest, and gripping some of the most serious and difficult problems of the engineering and commercial worlds, at the very outset of its career, is an achievement which at once substantiates the claim of PAGE'S MAGAZINE to general public attention. The "get-up" of the Magazine is superb, and as a first number is remarkable for the attainment of both a journalist's and a printer's ideal. We desire to offer our heartiest congratulations.

Bertrams, Ltd., Engineers, St. Katherine's Works, Edinburgh, state: We think the first number most excellent and practical in every respect, and wish you every success.

David Bridge and Co., Engineers and Millwrights, Castleton, Manchester: PAGE'S MAGAZINE is an excellent production, and we unhesitatingly say, that if the reading matter can be kept up to the standard of No. 1, there is a great future for it.

The Reliance Lubricating Oil Co., 10 and 20, Water Lane, Great Tower Street, London, E.C., write: We consider that your Magazine is a thoroughly up-to-date production. It compares favourably with the very best of its numerous competitors; the printing, the illustrations, and the subject-matter all being alike excellent.

The Frictionless Engine Packing Co., Ltd., Harpurhey, Manchester, write: We have received the first number of your Magazine, and we congratulate you on the splendid issue. If it is followed up by others of equal merit, we feel sure that there will be no fear of its ultimate success.

M. Glover and Co., Sawmill Engineers, Holbeck, Leeds, say: Allow us to compliment you upon the completeness of this first issue, also upon the usefulness and variety of the literary matter. Many of the advertisements seem conspicuous for originality in style, and we also may say we like the particular size of paper.

The Scotch and Irish Oxygen Co., Ltd., Polmadie, Glasgow: It is at once perfectly evident that infinite pains and trouble have been taken and no expense has been spared to get the best thing possible. We consider it the best of the monthly magazines, and if it fully maintains the high standard of excellence of the number before us there is no doubt that the favouring breath of general approval will fully fill the sails.

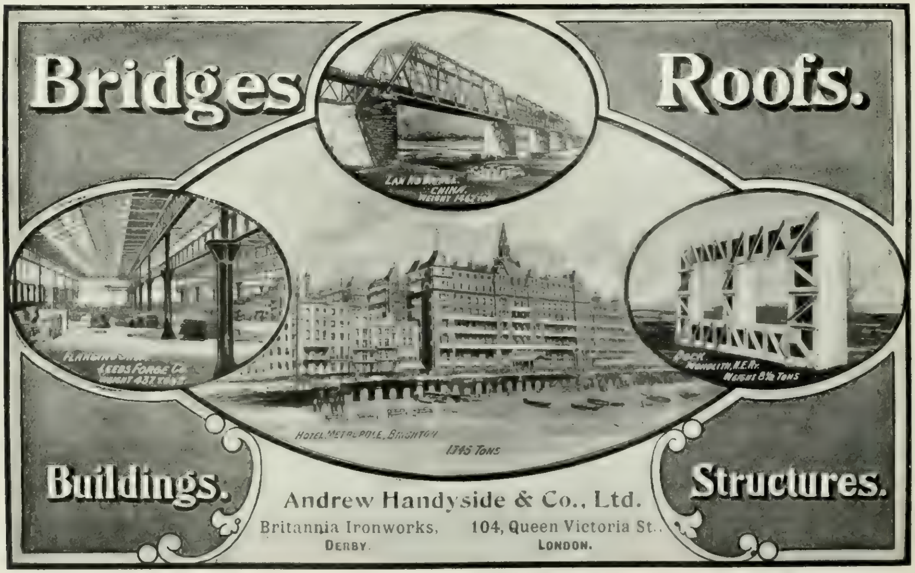
The Auto-Machinery Co., Ltd., Read Street, Coventry: After looking through PAGE'S MAGAZINE we must acknowledge it is a first-class production. We think the articles on various subjects are exceedingly good and the printing and general get-up very up-to-date and quite artistic.

T. S. McInnes and Co., Ltd., Manufacturers of Engineering Instruments, Clyde Place, Glasgow: The articles in the Magazine are certainly, in our opinion, of an interesting, practical, and varied nature, and the general arrangement both original and pleasing. If subsequent issues maintain the same high standard as the first, we should imagine your venture cannot but commend itself to the trade generally, and that its success is assured.

Mosses and Mitchell, 70-71, Chiswell Street, London, E.C.: We heartily congratulate you on the advent of No. 1. . . . We consider it excellent, the articles being above the usual magazine standard.

The International Electrical Engineering Co.: The well-chosen series of articles will, we feel sure, carry this Magazine into the Colonies and foreign countries, which is very essential from the advertiser's standpoint. We think it is of great interest to technical men, and if future issues are as successful to us as the present one, we shall be satisfied.

Henry Crowther, Engineer and General Millwright, Cleckheaton, writes: The work speaks for itself, and I congratulate you on your achievement. The articles are well chosen, and the writers show a full grasp of the subjects. The illustrations are very fine, and the advertisements are a picture.



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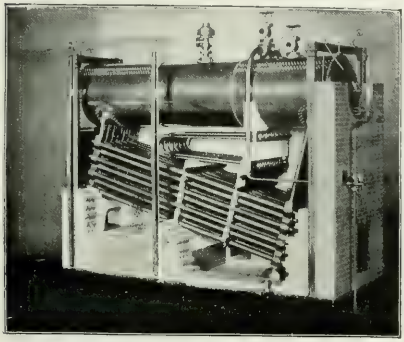
Roofs.
LAN HO BRIDGE. CHINA. WEIGHT 1462 TONS
LEEDS FORGE CO. WEIGHT 437 TONS
HOTEL METROPOLE, BRIGHTON
1745 TONS
WEIGHT 8½ TONS
Buildings.
Structures.
Andrew Handyside & Co., Ltd.
Britannia Ironworks, DERBY.
104, Queen Victoria St., LONDON.

BABCOCK & WILCOX, Ltd., Engineers and Manufacturers of

Patent Water-Tube Steam Boilers.

OVER 3,000,000 H.P. IN USE IN ALL INDUSTRIES.

The only Water-Tube Boiler which gained the **GRAND PRIX** (Highest Award) at the Paris International Exhibition, 1900.



Babcock and Wilcox Boiler, fitted with Superheater.

Safe, Economical (as to space and fuel), and Durable. Perfect Water Circulation. Spacious Steam Room. Easily Transported. Perfectly Accessible for Cleaning Externally and Internally.

Complete Installations of Steam Piping and Boiler House Plants.

ALSO WATER-TUBE MARINE BOILERS.

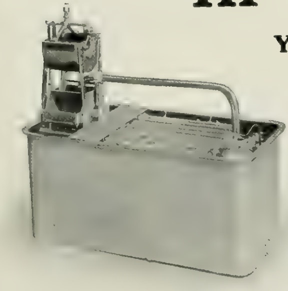
ESTIMATES AND PLANS ON APPLICATION

Head Office—
LONDON: Oriel House, Farringdon Street, E.C.; and Branches.

A valuable treatise on "Steam" and "Accessories" Catalogue free on application, to Engineers and Steam Users.

WORKS: RENFREW, SCOTLAND.

Why have Scale in your Boilers?



You can avoid this by using the

BRUUN-LOWENER WATER SOFTENER.

Write for Full Particulars.

LASSEN & HJORT,
Engineers,
52, Queen Victoria St., LONDON, E.C.

Is it money you want?

Yes?

Then bear in mind the following facts:

If you use **McPHAIL & SIMPSONS'**

Patent Dry Steam Generator . . and Superheater

A saving of not less than 15 per cent. of your expenditure in Fuel is guaranteed.

Some additional Advantages :—

- Improved evaporative efficiency of the boiler.
- Perfectly dry steam.
- The generation of superheated steam at a controllable temperature.
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APPLICABLE TO ALL STEAM BOILERS.

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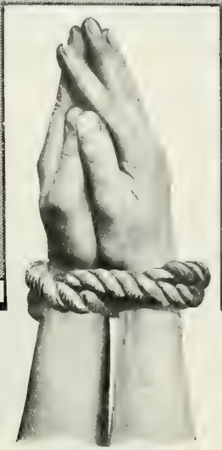

ARE YOUR HANDS TIED?

By the opposition and prejudice of a short-sighted municipal policy in the matter of refuse disposal—a policy which involves burking the question, doing the work in the most unsatisfactory manner, and losing opportunities of saving the rates?

A visit to Darwen or to one of the destructor plants erected by us in your more immediate neighbourhood should do much to dispel fallacious notions.

The Meldrum Destructor goes to the root of the matter, effectually disposing of the refuse once and for all. Not merely eliminating the undesirable, it conserves the valuable residue, and proves at once an indefatigable scavenger and money-maker. Wideawake corporations are using the surplus heat for steam power in their electric light and tram departments.

For full particulars of the "Simplex" and "Beaman and Deas" Destructors write to

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MANCHESTER,
England.

66, Victoria Street, Westminster,
LONDON.

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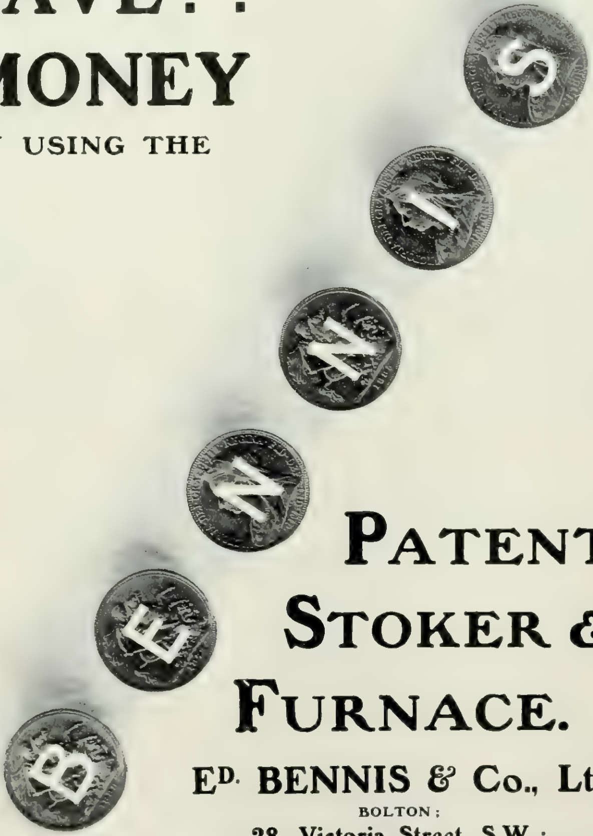
MONEY
BY USING THE



PATENT
STOKER &
FURNACE.

Ed. BENNIS & Co., Ltd.,
BOLTON;
28, Victoria Street, S.W.;
and at MANCHESTER,
GLASGOW, &c.

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DUFF GAS.

The Best and Cheapest for Heat or Power. Over 2,000 Duff Patent Gas Producers in daily use.

GAS for Heating.

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GAS for Power.

Producer Gas Specialities.
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Furnace Work of all Kinds.

* * * *

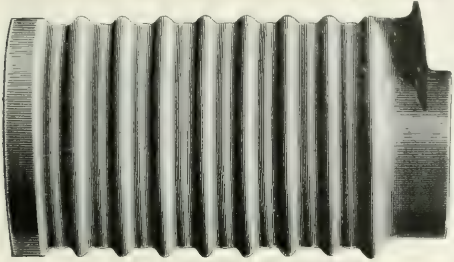
W. F. MASON, Ltd.,
Engineers and Contractors,
MANCHESTER.

CHEAPER FUEL—
MORE STEAM—
NO SMOKE—
ECONOMISER RESISTANCE
overcome and
SUDDEN DEMANDS
for MORE STEAM
instantly met—
have made the

STURTEVANT
System of
INDUCED DRAFT
an essential feature
of a modern
POWER PLANT.

Tall Chimneys are Things of the Past.
Existing Boiler Plants can be enlarged without altering Chimney.
Treatise G. 110, and the address of the Installation nearest you free on application.

Telegrams "FLUES LEEDS." Telephone National 1671. A1 & A B C Codes used.



ASHLIN 1897 PATENT WITHDRAWABLE FURNACE

Deighton's Patent Flue & Tube Company, Ltd.

DEIGHTON'S PATENT FURNACE.

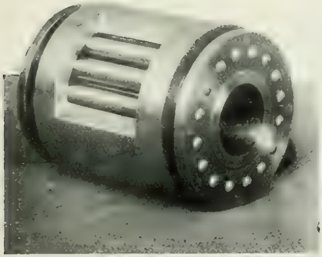
The Destructive Tests have proved the DEIGHTON FURNACE to be the strongest to resist collapse ever made.

It is also unequalled for Uniformity of Thickness and Easy Scaling.

MAKERS OF MARINE and LAND BOILER FURNACES.

Awarded 2 Bronze Medals, Paris Exhibition, 1900.

Vulcan Works,
Pepper Road, LEEDS.



The Roller Bearing complete, with part of Outer Bush cut away disclosing Rollers.

"Auto" Roller Bearings

FOR MOTOR=CARS, LORRIES, TROLLEYS, TRAMCARS, CRANES, AND OTHER MACHINERY.

SAVING OVER PLAIN BEARINGS.

70 per cent. less friction and 70 per cent. less starting effort compared with the best plain bearings.

Also BALL BEARINGS OF ALL KINDS.

A ROLLER BEARING may be seen by appointment running at 1,350 revolutions per minute, with a load of ONE TON on a 1 in. diameter shaft.

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NO BRASS or BRONZE FOUNDER

Can afford to overlook the advantage of using

"CROMIL" CUPRO-SILICON

Pamphlet on application to . . .

CROSIER, STEPHENS & Co.,
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Also at . .
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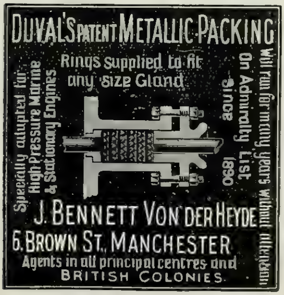
TRIUMPH STOKER

TRIUMPH STOKER L^D.
39, VICTORIA ST., LONDON.



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Rings supplied to fit any size Gland

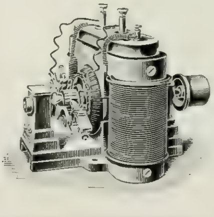
Specially adapted for High Pressure Marine & Stationary Engines

On Admiralty List since 1890

Will run for many years without attention

J. BENNETT VON DER HEYDE
6, BROWN ST., MANCHESTER
Agents in all principal centres and BRITISH COLONIES.

MOTORS & DYNAMOS IN SMALL SIZES.



Electric Fans,
Hand and
Foot=Power
Driving Gears,
for Dynamos, &c.

CATALOGUE ON APPLICATION.

The Crypto Works Co., Ld.,
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Telegrams: "Commutator, London."

HEYWOOD & BRIDGE'S

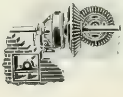
Improved Patent Friction Clutch.

(A CLUTCH FOR ALL DRIVES.)

HUNDREDS OF REPEAT ORDERS. THOUSANDS WORKING.

OVER 200 OF OUR CLUTCHES SUPPLIED TO ONE FIRM ALONE.

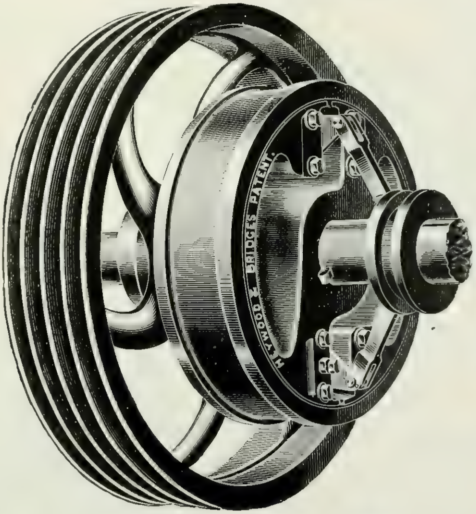
Shaft Coupling



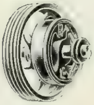
Counter Drive.

Double Clutch

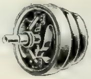
Dust-Proof


HEYWOOD & BRIDGE'S PATENT.

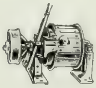
Dynamo Drive.



General Drive.



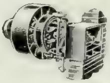
Speed Cone.



Winding Clutch.

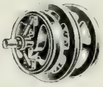
NEW WORK. 60 PAGES. FREE.

COMPLETE CLUTCH INSTALLATIONS OUR SPECIALITY.



Aux Drive.

In Halves.



Heavy Hauling

In a large number of establishments much of the power exerted in driving the gearing is utterly wasted, for the simple reason that though at times a part or the whole of the machinery in one or more rooms may be entirely at rest, **the main shafting is kept in motion,** thereby entailing the consumption of unnecessary power, to say nothing of the useless wear and tear of gearing, belting, etc. Our Friction Clutches, judiciously located throughout your works or mill, will not only effect a large saving in the motive power required, but may be the means of avoiding serious accident by permitting any attendant to instantly stop the main shafting or machinery. Their superiority over the usual claw couplings, taper cones, inferior clutches, etc., renders them specially applicable for connecting and disconnecting separate machines from the main shafting: for instance, those classes of machinery of which it is an essential feature that they can be started and stopped either gradually or instantly without the slightest shock or jar. Full details on application.

DAVID BRIDGE & CO.,

Castleton Iron Works, ROCHDALE, LANCS.

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Laundry . .

Machinery

AND

Of every possible description.

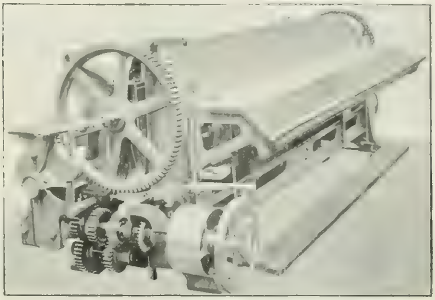
Cooking Apparatus

The experience of more than half a century enables us to give expert advice in every department of laundry work and in the case of large establishments, to advise upon, and if necessary reorganize the whole of the arrangements from the Receiving Office to the Packing and Delivery Rooms. The largest makers of laundry machinery in the world, we rely upon the name "Summerscales" to carry its own guarantee. At our offices in Coney Lane we have a large staff of draughtsmen constantly engaged in preparing designs for public and private laundries. Our advice costs nothing; our machinery secures the legitimate equivalent of the best workmanship, and its efficiency is constantly proved by repeat orders which reach us from all parts of the world.

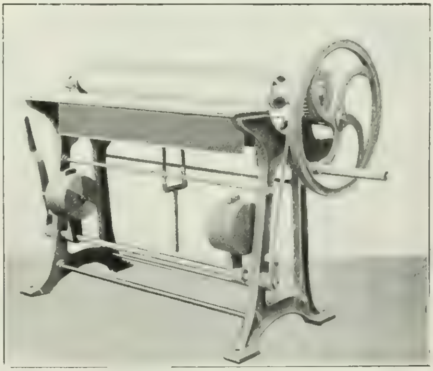
W. SUMMERSCALES & SONS, Ltd.,

Phoenix Foundry,

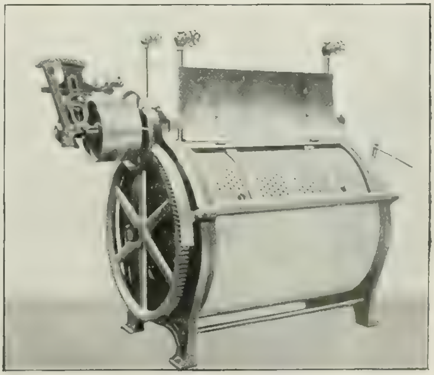
KEIGHLEY, ENGLAND.



Ironing and Finishing Machine



Ironing Machine

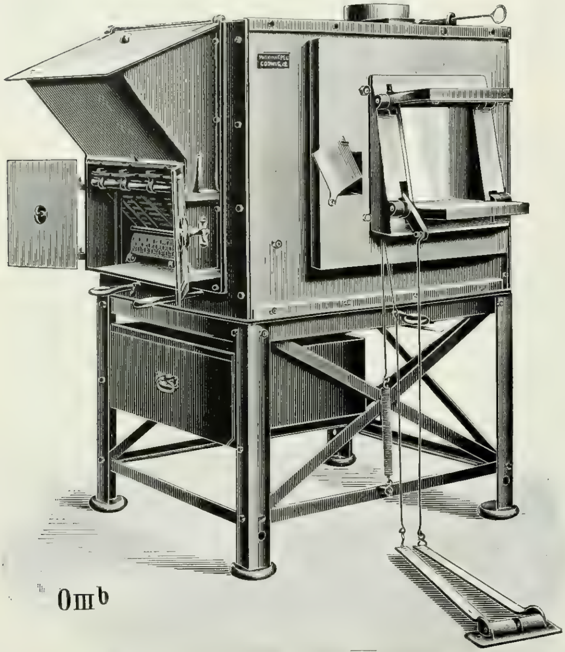


Washing, Boiling, Rinsing, and Blueing Machine

MASCHINEN= FABRIK PEKRUN

IN

COSWIG (SA.), NEAR DRESDEN,



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Hardening

Annealing and Case=Hardening—

Furnaces.

For COAL FIRING without BLAST, with one or more Fire=proof muffles (R), completely shut off against gases and cold air. Complete uniform heating of the steel to be hardened. Easily handled. Low cost of maintenance.

TWELVE DIFFERENT SIZES.

Exhibited at the Paris Exhibition, 1900.
Palais d'Electricite.

Agents for Great Britain:

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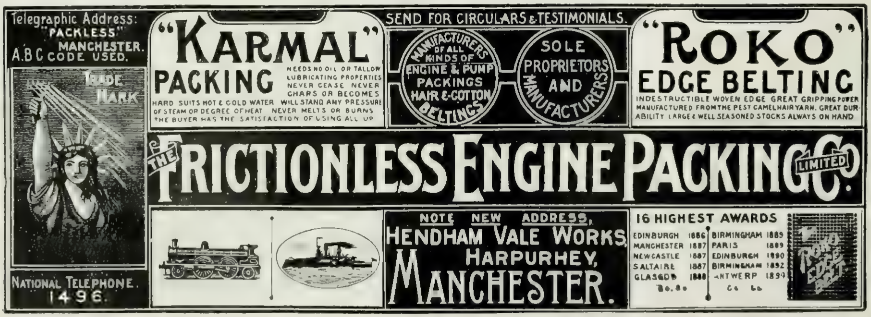

Telegraphic Address:
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MANCHESTER.
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TRADE MARK

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"KARMAL" PACKING

NEEDS NO OIL OR TALLOW LUBRICATING PROPERTIES NEVER CEASE NEVER CHARS OR BECOMES HARD SUITS HOT & COLD WATER WILL STAND ANY PRESSURE OF STEAM OR DEGREE OF HEAT NEVER MELTS OR BURNS THE BUYER HAS THE SATISFACTION OF USING ALL UP

SEND FOR CIRCULARS & TESTIMONIALS.

MANUFACTURERS OF ALL KINDS OF ENGINE & PUMP PACKINGS HAIR & COTTON BELTINGS

SOLE PROPRIETORS AND MANUFACTURERS

"ROKO" EDGE BELTING

INDESTRUCTIBLE WOVEN EDGE GREAT GRIPPING POWER MANUFACTURED FROM THE BEST CAMELHAIR YARN. GREAT DURABILITY LARGE & WELL SEASONED STOCKS ALWAYS ON HAND

THE FRICTIONLESS ENGINE PACKING Cᴼ. LIMITED

NOTE NEW ADDRESS,
HENDHAM VALE WORKS,
HARPURHEY,
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16 HIGHEST AWARDS

EDINBURGH	1886	BIRMINGHAM	1889
MANCHESTER	1887	PARIS	1889
NEWCASTLE	1887	EDINBURGH	1890
SALTAIRE	1887	BIRMINGHAM	1892
GLASGOW	1888	ANTWERP	1894
&c. &c.		&c. &c.	

NO DANGER FROM BROKEN GAUGE GLASSES.

Winn's PATENT

RELIABLE

Water Gauges.

SPECIAL LOCOMOTIVE PATTERN.

* * *

AUTOMATIC VALVES IN BOTH STEAM AND WATER ARMS, WHICH INSTANTLY CLOSE UPON THE GLASS BREAKING, AND IN NO WAY INTERFERE WITH THE OPERATION OF BLOWING THROUGH.

CLEAR STRAIGHT PASSAGES UNOBSTRUCTED BY THE AUTOMATIC VALVES, MAKING FALSE WATER LEVEL IMPOSSIBLE.

NO LOOSE BALLS; EACH AUTOMATIC VALVE ATTACHED TO ITS RESPECTIVE VALVE PLUG.

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CHARLES WINN & CO.

St. Thomas' Works,
Granville Street, BIRMINGHAM.

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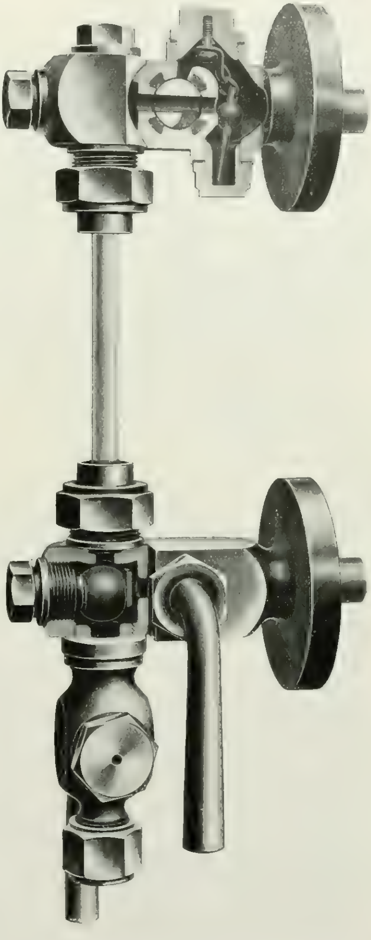
CARDIFF: 21, West Bute Street. NEWCASTLE-ON-TYNE: 26, Grey Street.



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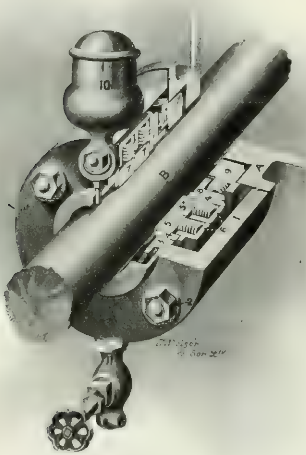

OVER 130,000 FITTED

TO ALL TYPES OF ENGINES IN EUROPE, ASIA, AFRICA, AND AMERICA.

Supplied to the British, United States, Dutch, Spanish, Japanese, &c., Navies. Friction Decreased. Power and Fuel Saved. Vacuum Improved. Automatic Self-Adjusting. Steam Setting. Entirely Metallic.

United States Metallic Packing CO., LTD.,

Telegrams: "Metallic, Bradford."
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BRADFORD.

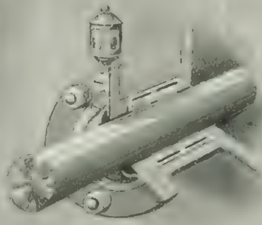
Also Makers of

THE BRADFORD PORTABLE **Power Drill & Reamer.**

AIR COMPRESSORS and PNEUMATIC HAMMERS. PNEUMATIC HOISTS. PNEUMATIC PAINTERS. PNEUMATIC RIVETERS, &c., &c.

COMBINATION METALLIC PACKING

FOR



HORIZONTAL ENGINES
LOCOMOTIVES
DYNAMO ENGINES, PUMPS &C

80,000 SETS FITTED

THE COMBINATION METALLIC PACKING CO. LD
HILLGATE, GATESHEAD-ON-TYNE

MOSSES & MITCHELL'S

Genuine Vulcanized Fibre

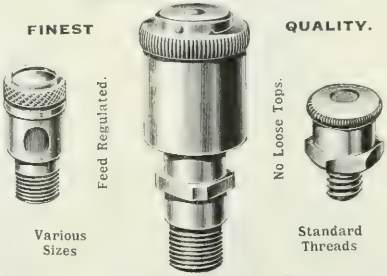
SHEETS.
TUBES.
RODS.
INSULATORS.
VALVES.
WASHERS.
STAPLES.

WRITE FOR PAMPHLET AND PRICES.

MOSSES & MITCHELL,
70-71, CHISWELL STREET, LONDON, E.C.

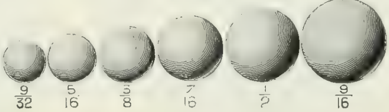
.. PATENT ..
LUBRICATORS, OIL CONDUCTORS, GREASE CUPS.

FINEST QUALITY.

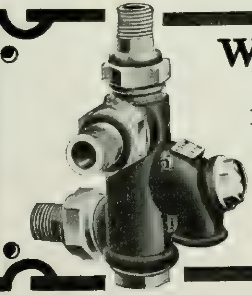


Feed Regulated.
No Loose Tops.
Various Sizes
Standard Threads

BEARING BALLS.



Cast Steel and Phosphor Bronze.
SEND FOR NEW CATALOGUE.
TEALE & CO., Birmingham.

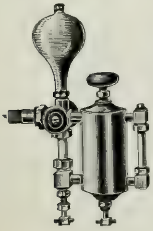


W. H. WILLCOX & Co., Ltd.
23, 34 and 36, Southwark Street, LONDON.

For **ALL** Boilers.

Acknowledged the best for Traction Engines, &c.

OVER 250 000 IN USE.
HANDLES HOT WATER. Will Deliver at Boiling Point.
Works on High and Low Pressures.
AUTOMATIC and RESTARTING. Lifts up to 22 ft.
IN 3 STYLES AND 16 DIFFERENT SIZES.



ASHTON'S SIGHT-FEED LUBRICATORS

NEVER FAIL. Thousands Sold.

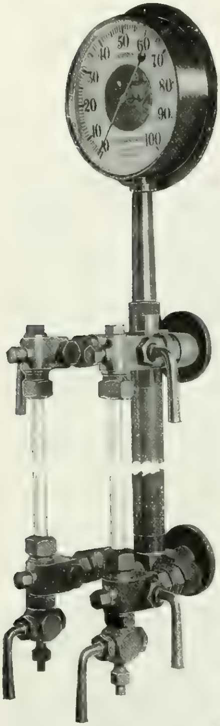
— SENT FOR ONE MONTH'S FREE TRIAL. —

Size	$\frac{1}{3}$	$\frac{1}{2}$	1	2	4	Pints.
Price	36/- ...	39/- ...	45/- ...	75/- ...	110/-	each.

Do not confuse this with the cheap, unfinished, American make.

Ask for List 36.

THOMAS A. ASHTON, Ltd., Norfolk Street, Sheffield.



Complete Self-contained Boiler Equipment.

Hunt and Mitton,

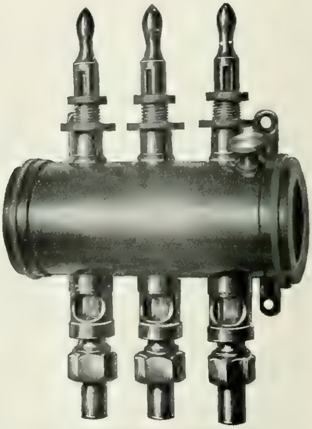
MAKERS OF

HIGH-CLASS FITTINGS ONLY

for Engines and Boilers.

Engineers' Brass Finishers.

CROWN BRASS WORKS,
OOZELLS STREET NORTH,
BIRMINGHAM.



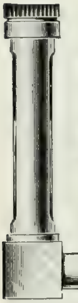
Patent "End Sight" Oil Distributing Box.

Telegrams
"MITTON, BIRMINGHAM."
Telephone: 304

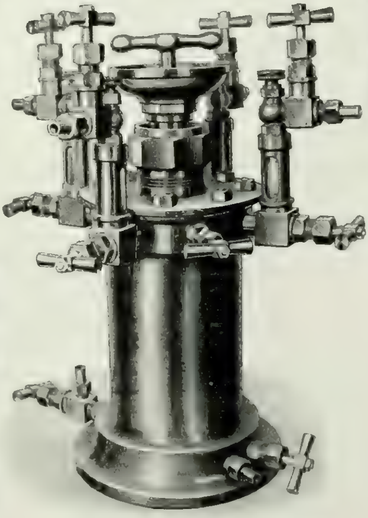
Sight Feed Oil Syphon.

Centrifugal Crank Pin Oiler.

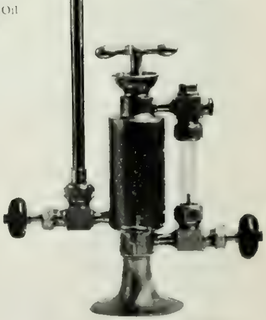
Solidified Oil Cup



Oil Gauge Indicator for Solid Bearings.



Steam Cylinder Grease Cups.



Killingbeck's Sight Feed Lubricator.

"VACUUM" WASTE OIL FILTERS (Patent).

SAVE INITIAL OUTLAY IN A SHORT TIME.

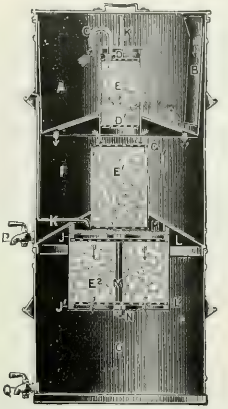
Prices from **37s. 6d.** to **£21** each, with filtering capacities varying from 2 gallons **per week** to 60 gallons **per day.** [illegible]
Largely adopted by gas engine and other machinery users. Invaluable for **Electric Lighting Stations.** Full particulars on application [illegible]

PATENT OIL STORAGE CABINETS.

Closed.

N.B. Vacuum Oils (after use) do not lose their lubricating properties in filtering unlike other manufactures in this respect. The filter merely separates the dirt and other foreign matter which get into the oils **when on the** machinery.

"B" TYPE
PATENT FILTER.

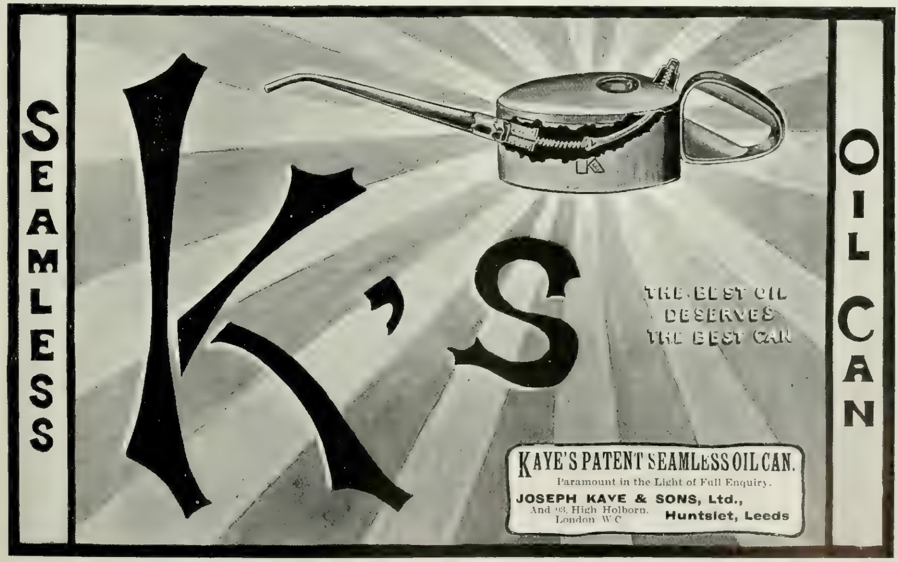


VACUUM OILS are used and recommended by leading Engineering firms.

Special grade for Super-heated Steam.

Open.

VACUUM OIL COMPANY, L^TD., Norfolk Street, LONDON, W.C.

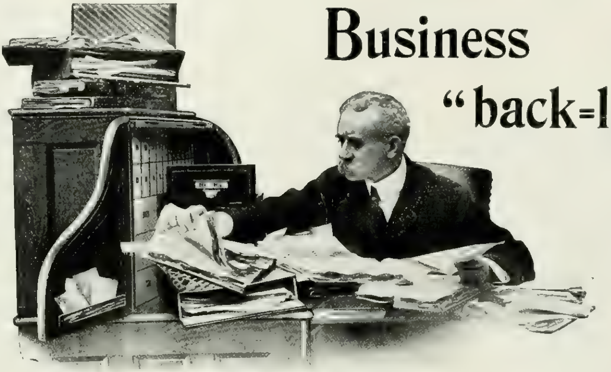


KAYE'S PATENT SEAMLESS OIL CAN.

Paramount in the Light of Full Enquiry.

JOSEPH KAYE & SONS, Ltd.,
And 93, High Holborn, London W.C.
Huntslet, Leeds

Business "back-lash."



The Proprietor doing a Clerk's Work.

When a driving gear is reversed there's "back-lash" through the whole train, and so much lost motion. When a proprietor stops to do a clerk's work the whole business suffers a lost profit.

No man whose time is valuable can afford to spend one moment hunting or waiting for letters, drawings, or business data, which a clerk ought to produce in one minute. With a Library Bureau system the clerk can do it.

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THE UNIVERSAL CARBURIZER.

The Latest and Most Efficient Process for Case-Hardening Iron and Low Grade Steel. . .

Has many advantages over every other known process:

Free Samples on Application

- Deeper penetration in one-fifth the time required by ordinary material.
- Does not blister or otherwise damage the surface of the metal treated.
- Does not produce brittleness.
- Specific weight less than most other material.

Price £10 per Ton, 12/6 per Cwt. Carriage Paid.

The BRITISH CARBURIZING Co., Ld.,
Castle Wharf, Hampton Wick, Middlesex.
W. H. CROOK, Secretary.

The "McINNES-DOBBIE" PATENT Indicators

- - for - -

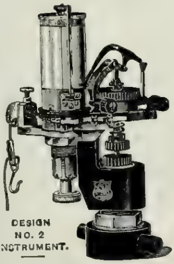
HIGH & LOW SPEEDS.

In Two Types:—

External Spring and - - - Enclosed Spring

Each made in several Forms and Sizes.

SPECIAL INDICATORS for Gas Engines.



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EXTERNAL PRESSURE SPRING TYPE.

Sole Makers:
T. S. McInnes & Co., Ld.,
INDICATOR MAKERS TO THE ADMIRALTY,
41 & 42, Clyde Place = = GLASGOW.
London Office, 113, FENCHURCH ST., E.C.

Best Work requires Best Tools.

The CORRECT TOOL for WRITING IS UNQUESTIONABLY THE "SWAN" Fountain Pen.

Three Sizes, 10s. 6d., 16s. 6d., 25s.

All Prices, 10s. 6d. to £20.

MAY BE POSTED TO ALL PARTS OF THE WORLD.

Reduced Facsimile Improved "Swan" Fountain Pen, Size 3, 16s. 6d. Closed for pocket, 5¼in. long ; open, 6¾in.

QUALITY.—14ct. Gold Nib, Selected Iridium Points, Best Vulcanite.

SYSTEM.—Simple and Right.

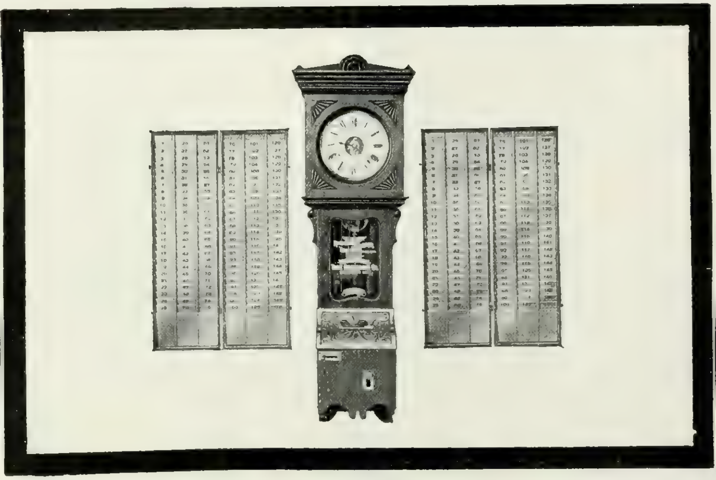
ACTION.—Instant, Continuous, and Sure.

DURABILITY.—Beyond that of Grosses of Steel Pens.

Improved Size 3 "Swan" Pen with 18ct. Rolled Gold Bands, 21s.

SOLD BY STATIONERS EVERYWHERE COMPLETE CATALOGUE FREE.

Mabie, Todd & Bard, Manufacturers,
93, Cheapside, London, E.C.
95a, Regent St., W.; 3, Exchange St., Manchester; and 37, Ave. de l'Opera, Paris.



TIME,

DISCIPLINE,

EXACTNESS,

Are the THREE FACTORS OF SUCCESS
IN MANUFACTURING ORGANIZATION

Our System, with its many variations and great adaptability, ensures all three.

INTERNATIONAL TIME RECORDING Co.,

171, Queen Victoria Street, LONDON, E.C.,
and 19, Waterloo Street, GLASGOW.

Send for Pamphlet: "Cost Keeping & How to do it."

Employers and Employes mutually satisfied
The Cheapest and most Perfect Automatic
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The "DEY" TIME REGISTER.

HIGHEST
TESTIMONIALS
FROM THOUSANDS
OF USERS.

No Keys, Checks, Cards, Pin Pricks, or Disputes. 1,500 persons registered in five minutes. Collusion, favouritism, or errors are impossible. The exact minute printed in bold type on time-sheet. Compare this with other systems.

ENGLISH manufacture throughout.

Full particulars from the Proprietors and Manufacturers:—

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Telegraphic Address: "Sonnez, Liverpool." Telephone: 7150 Liverpool.

London Offices: 100c, QUEEN VICTORIA STREET, E.C.
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This is the object to be attained in all printing for advertising purposes. It is only to be secured by a proper use of

The Art of Display.

It is this which, properly applied, pleases the eye, arrests attention, and insures that the salient points of your business announcement are clearly and effectively set out.

We are experts in "Display," and it is our business to use our knowledge for your advantage.

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When you are placing your next order, and we shall be glad to submit estimate.

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SOUTHWOOD, SMITH & CO., LTD.,
PRINTERS,
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LONDON, E.C.

WALTER JUDD, LTD.,

Advertising Contractors to H.M. Government,

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LONDON, E.C.

WALTER JUDD, LTD., MAKE A SPECIALITY OF ENGINEERING FIRMS' ADVERTISEMENTS, AND ARE PREPARED TO SUBMIT ESTIMATES AND DESIGNS FREE OF CHARGE.

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WALTER JUDD, LTD.,
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CONTRACTORS TO H.M. GOVERNMENT, FOREIGN GOVERNMENTS HOME & FOREIGN RAILWAYS.
INCORPORATING FIRMS ESTABLISHED OVER 100 YEARS.

FLEMING, BIRKBY & GOODALL, LTD.

HEAD WORKS & REGISTERED OFFICES,
West Grove Mill, HALIFAX.

STANDARD OAK TANNED LEATHER BELTING.

13 INTERNATIONAL EXHIBITION AWARDS.

"GILBERT" WOOD SPLIT PULLEYS. PRINCIPAL AGENTS. LARGE STOCK HELD.

SOLE MAKERS OF "TEON" BELTING the Premier Heat, Steam, Water & Acid Proof Belt.

HYDRAULIC LEATHERS and all kinds of MILL & MECHANICAL LEATHERS.

SEWN AND SOLID WOVEN COTTON BELTING.

"SUPERIOR" HAIR BELTING.

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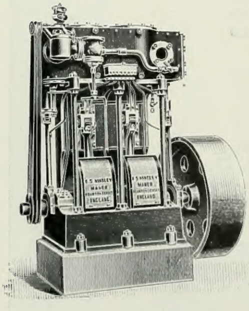
BELTING

E. S. HINDLEY & SONS

Works:
BOURTON, Dorset.

London Show Rooms and Stores:
11, Queen Victoria St., E.C.

STEAM ENGINES



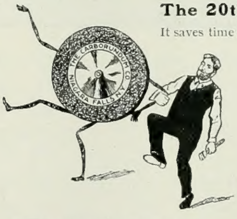
HIGH SPEED,
SLOW SPEED,
VERTICAL,
HORIZONTAL,
SIMPLE,
COMPOUND.

STEAM BOILERS.

If it is Money you Want—Use CARBORUNDUM

The 20th Century Abrasive.

It saves time; time saved means money saved.

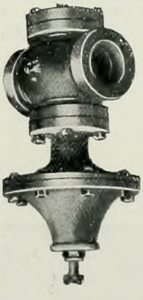

THE CARBORUNDUM CO.
NIAGARA FALLS N.Y.

WORKMEN LIKE THEM.

Others use it, why not YOU?

Write Us or our Agents for Catalogue and Prices.

THE POLISHERS SUPPLY CO.,
British Agents,
27, Chancery Lane,
LONDON, W.C.
Telegrams:
"CRUORIN, LONDON."
A B C and Lieber Codes used.



Reducing Valves.

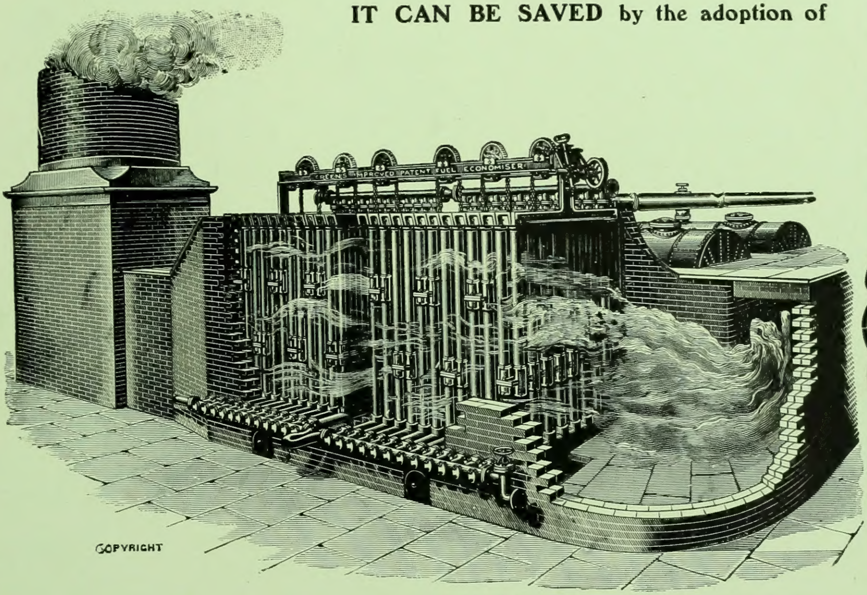
Steam Traps.

CAPABLE of performing more variable duties than any other trap or valve on the market.

BRITISH STEAM SPECIALTIES, LTD.,
FLEET STREET, LEICESTER.
Tel.: "Boss."

Why Throw Away . . . 15 to 25 % of COAL in WASTE HEAT —up the Chimney?

IT CAN BE SAVED by the adoption of


GREEN'S IMPROVED PATENT FUEL ECONOMISER
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GREEN'S ECONOMISER.

Can be applied to every kind of Steam Plant.

ILLUSTRATED CATALOGUE from Inventors and Patentees—

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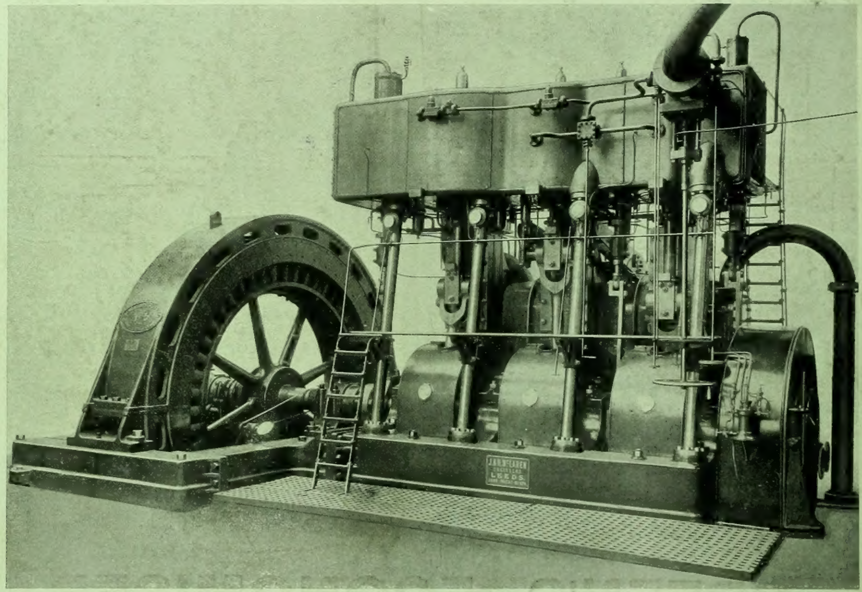
2, Exchange Street, MANCHESTER.

Telegrams: "ECONOMISER."

WOLVERHAMPTON EXHIBITION . .
Green's Economiser Pavilion, opposite side entrance to Machinery Hall.

HIGH-CLASS

Electric Lighting
Engines.



McLaren's 1,000 I.H.P. Triple Expansion Engine in connection with Siemens' Alternator at South Shields Electric Light Station.

ALL SIZES FROM
200 to 3,500 I.H.P.

Specifications and Quotations on application to—

J. & H. McLAREN,
Midland Engine Works, LEEDS.

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